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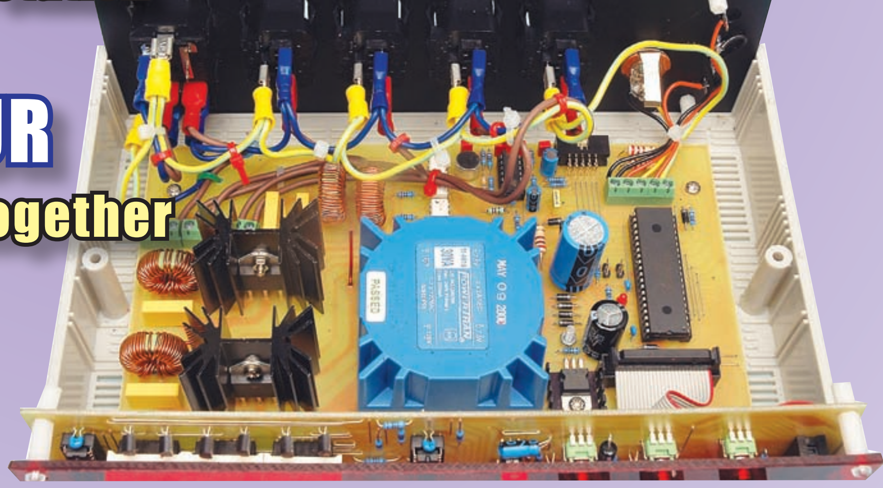

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VM160T	4 Channel RF Replacement transmitter	17.05
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VM163	Panel Clock Module	25.17
VM164	Mini Dimmer, Push button control *(Due June)*	14.78
VM165	0-10V DC Controlled Dimmer *(Due April)*	48.95
VM179	Proximity Card Reader Module	25.65

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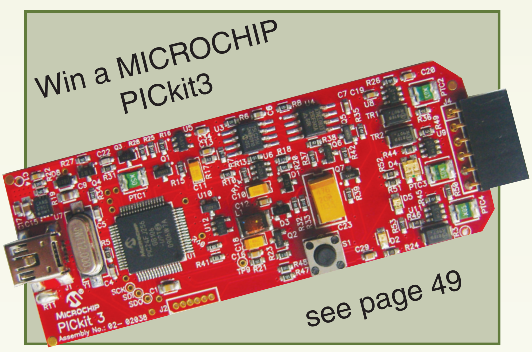

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Hot New Products!

Here are a few of the most recent products added to our range. See website or join our email Newsletter for all the latest news.

4-Channel Serial Port Temperature Monitor & Controller Relay Board

4 channel computer serial port temperature monitor and relay controller with four inputs for Dallas DS18S20 or DS18B20 digital thermometer sensors (£3.95 each). Four 5A rated relay channels provide output control. Relays are independent of sensor channels, allowing flexibility to setup the linkage in any way you choose. Commands for reading temperature and relay control sent via the RS232 interface using simple text strings. Control using a simple terminal / comms program (Windows HyperTerminal) or our free Windows application software.
Kit Order Code: 3190KT - **£69.95**
Assembled Order Code: AS3190 - **£84.95**

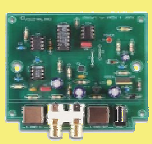
40 Second Message Recorder

Feature packed non-volatile 40 second multi-message sound recorder module using a high quality Winbond sound recorder IC. Standalone operation using just six onboard buttons or use onboard SPI interface. Record using built-in microphone or external line in. 8-24 Vdc operation. Just change one resistor for different recording duration/sound quality. sampling frequency 4-12 kHz.
Kit Order Code: 3188KT - **£28.95**
Assembled Order Code: AS3188 - **£36.95**
120 second version also available

Bipolar Stepper Motor Chopper Driver

Get better performance from your stepper motors with this dual full bridge motor driver based on SGS Thompson chips L297 & L298. Motor current for each phase set using on-board potentiometer. Rated to handle motor winding currents up to 2 Amps per phase. Operates on 9-36Vdc supply voltage. Provides all basic motor controls including full or half stepping of bipolar steppers and direction control. Allows multiple driver synchronisation. Perfect for desktop CNC applications.
Kit Order Code: 3187KT - **£39.95**
Assembled Order Code: AS3187 - **£49.95**

Video Signal Cleaner



Digitally cleans the video signal and removes unwanted distortion in video signal. In addition it stabilises picture quality and luminance fluctuations. You will also benefit from improved picture quality on LCD monitors or projectors.
Kit Order Code: K8036KT - **£32.95**
Assembled Order Code: VM106 - **£49.95**

Most items are available in kit form (KT suffix) or assembled and ready for use (AS prefix).

Motor Speed Controllers

Here are just a few of our controller and driver modules for AC, DC, Unipolar/Bipolar stepper motors and servo motors. See website for full details.

DC Motor Speed Controller (100V/7.5A)

Control the speed of almost any common DC motor rated up to 100V/7.5A. Pulse width modulation output for maximum motor torque at all speeds. Supply: 5-15Vdc. Box supplied. Dimensions (mm): 60Wx100Lx60H.
Kit Order Code: 3067KT - **£17.95**
Assembled Order Code: AS3067 - **£24.95**

Computer Controlled / Standalone Unipolar Stepper Motor Driver

Drives any 5-35Vdc 5, 6 or 8-lead unipolar stepper motor rated up to 6 Amps. Provides speed and direction control. Operates in stand-alone or PC-controlled mode for CNC use. Connect up to six 3179 driver boards to a single parallel port. Board supply: 9Vdc. PCB: 80x50mm.
Kit Order Code: 3179KT - **£15.95**
Assembled Order Code: AS3179 - **£22.95**

Computer Controlled Bi-Polar Stepper Motor Driver

Drive any 5-50Vdc, 5 Amp bi-polar stepper motor using externally supplied 5V levels for STEP and DIRECTION control. Opto-isolated inputs make it ideal for CNC applications using a PC running suitable software. Board supply: 8-30Vdc. PCB: 75x85mm.
Kit Order Code: 3158KT - **£23.95**
Assembled Order Code: AS3158 - **£33.95**

Bidirectional DC Motor Speed Controller

Control the speed of most common DC motors (rated up to 32Vdc/10A) in both the forward and reverse direction. The range of control is from fully OFF to fully ON in both directions. The direction and speed are controlled using a single potentiometer. Screw terminal block for connections.
Kit Order Code: 3166v2KT - **£22.95**
Assembled Order Code: AS3166v2 - **£32.95**

AC Motor Speed Controller (600W)

Reliable and simple to install project that allows you to adjust the speed of an electric drill or 230V AC single phase induction motor rated up to 600 Watts. Simply turn the potentiometer to adjust the motors RPM. PCB: 48x65mm. Not suitable for use with brushless AC motors.
Kit Order Code: 1074KT - **£14.95**
Assembled Order Code: AS1074 - **£23.95**

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Order Code EPL500 - **£179.95**
Also available: 30-in-1 **£19.95**, 50-in-1 **£29.95**, 75-in-1 **£39.95** £130-in-1 **£44.95** & 300-in-1 **£69.95** (see website for details)

Tools & Test Equipment

We stock an extensive range of soldering tools, test equipment, power supplies, inverters & much more - please visit website to see our full range of products.

Two-Channel USB Pc Oscilloscope

This digital storage oscilloscope uses the power of your PC to visualize electrical signals. Its high sensitive display resolution, down to 0.15mV, combined with a high bandwidth and a sampling frequency of up to 1GHz are giving this unit all the power you need.
Order Code: PCSU1000 - **£399.95**

Personal Scope 10MS/s

The Personal Scope is not a graphical multimeter but a complete portable oscilloscope at the size and the cost of a good multimeter. Its high sensitivity - down to 0.1mV/div - and extended scope functions make this unit ideal for hobby, service, automotive and development purposes. Because of its exceptional value for money, the Personal Scope is well suited for educational use.
Order Code: HPS10 - ~~£189.95~~ £169.95

See website for more super deals!

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- 4068B £0.19
- 4069UB £0.18
- 4070B £0.15
- 4071B £0.20
- 4072B £0.25
- 4073B £0.17
- 4075B £0.17
- 4076B £0.30
- 4075B £0.15
- 4077B £0.28
- 4078B £0.30
- 4081B £0.13
- 4082B £0.21
- 4085B £0.28
- 4086B £0.33
- 4093B £0.16
- 4094B £0.29
- 4098B £0.40
- 4099B £0.35
- 4502B £0.32
- 4503B £0.40
- 4508B £1.40
- 4510B £0.45
- 4511B £0.30
- 4512B £0.27
- 4515B £0.99
- 4516B £0.44
- 4518B £0.26
- 4520B £0.34
- 4521B £0.68
- 4526B £0.40
- 4527B £0.40
- 4529B £0.44
- 4532B £0.24
- 4536B £1.00
- 4538B £0.26
- 4541B £0.33
- 4555B £0.32
- 4556B £0.40
- 4584B £0.33
- 4585B £0.47
- 4724B £0.94
- 40106B £0.19
- 40109B £0.58
- 40174B £0.46
- 40175B £0.41

74HC Series

- 74HC00 £0.16
- 74HC02 £0.17
- 74HC03 £0.21
- 74HC04 £0.14
- 74HC08 £0.17
- 74HC10 £0.21
- 74HC11 £0.21
- 74HC14 £0.18
- 74HC20 £0.28
- 74HC27 £0.16
- 74HC30 £0.22
- 74HC32 £0.14
- 74HC42 £0.36
- 74HC73 £0.40
- 74HC74 £0.15
- 74HC75 £0.31
- 74HC85 £0.23
- 74HC86 £0.21
- 74HC107 £0.40
- 74HC123 £0.33
- 74HC125 £0.26
- 74HC126 £0.46
- 74HC132 £0.26
- 74HC133 £0.34
- 74HC137 £0.30
- 74HC138 £0.26
- 74HC139 £0.31
- 74HC151 £0.33
- 74HC153 £0.30
- 74HC154 £0.94
- 74HC157 £0.22
- 74HC158 £0.23
- 74HC161 £0.27
- 74HC162 £0.45
- 74HC163 £0.26
- 74HC164 £0.20
- 74HC165 £0.26
- 74HC173 £0.38
- 74HC174 £0.27
- 74HC175 £0.35
- 74HC193 £0.39
- 74HC195 £0.32
- 74HC240 £0.32
- 74HC241 £0.37
- 74HC244 £0.40
- 74HC245 £0.34
- 74HC251 £0.30
- 74HC253 £0.25
- 74HC257 £0.25
- 74HC259 £0.29
- 74HC273 £0.32
- 74HC299 £0.61
- 74HC365 £0.28
- 74HC367 £0.38
- 74HC368 £0.29
- 74HC373 £0.35
- 74HC374 £0.34
- 74HC390 £0.37
- 74HC393 £0.36
- 74HC563 £0.56
- 74HC573 £0.27
- 74HC574 £0.30
- 74HC595 £0.27
- 74HC597 £0.22
- 74HC688 £0.46
- 74HC4002 £0.31
- 74HC4017 £0.24
- 74HC4020 £0.36
- 74HC4040 £0.29
- 74HC4049 £0.31
- 74HC4051 £0.50
- 74HC4052 £0.34
- 74HC4053 £0.22
- 74HC4060 £0.23
- 74HC4075 £0.27
- 74HC4078 £0.32
- 74HC4511 £0.64
- 74HC4514 £0.84
- 74HC4538 £0.41
- 74HC4543 £0.90

74LS Series

- 74LS00 £0.28
- 74LS01 £0.14
- 74LS02 £0.38
- 74LS03 £0.21
- 74LS04 £0.30
- 74LS05 £0.14
- 74LS08 £0.19
- 74LS09 £0.15
- 74LS10 £0.27
- 74LS11 £0.17
- 74LS12 £0.25
- 74LS14 £0.36
- 74LS15 £0.24
- 74LS20 £0.27
- 74LS21 £0.20
- 74LS26 £0.17
- 74LS27 £0.25
- 74LS30 £0.20
- 74LS32 £0.23
- 74LS37 £0.31
- 74LS38 £0.18
- 74LS40 £0.14
- 74LS51 £0.24
- 74LS83 £0.38
- 74LS85 £0.48
- 74LS86 £0.25
- 74LS92 £0.45
- 74LS93 £0.44
- 74LS107 £0.30
- 74LS109 £0.21
- 74LS112 £0.24
- 74LS113 £0.23
- 74LS114 £0.36
- 74LS122 £0.31
- 74LS123 £0.31
- 74LS125 £0.28
- 74LS126 £0.25
- 74LS132 £0.47
- 74LS133 £0.36
- 74LS136 £0.23
- 74LS138 £0.33
- 74LS145 £0.56
- 74LS148 £0.64
- 74LS151 £0.29
- 74LS156 £0.36
- 74LS157 £0.22
- 74LS158 £0.21
- 74LS160 £0.48
- 74LS161 £0.32
- 74LS162 £0.44
- 74LS163 £0.32
- 74LS164 £0.43
- 74LS173 £0.24
- 74LS175 £0.30
- 74LS191 £0.27
- 74LS192 £0.60
- 74LS193 £0.50
- 74LS195 £0.24
- 74LS240 £0.32
- 74LS241 £0.32
- 74LS243 £0.30
- 74LS244 £0.41
- 74LS245 £0.45
- 74LS247 £0.60
- 74LS251 £0.24
- 74LS257 £0.24
- 74LS258 £0.24
- 74LS266 £0.14
- 74LS273 £0.32
- 74LS279 £0.24
- 74LS283 £0.47
- 74LS365 £0.21
- 74LS367 £0.21
- 74LS368 £0.21
- 74LS373 £0.43
- 74LS374 £0.38
- 74LS378 £0.62
- 74LS390 £0.34
- 74LS393 £0.33
- 74LS395 £0.26

74 Series

- 7407 £0.40

Linear ICs

- AD524AD £23.04
- AD548JN £2.48
- AD590JH £5.28
- AD595AQ £13.92
- AD620AN £9.88
- AD625JN £16.20
- AD633JN £5.93
- AD648JN £2.57
- AD654JN £5.51
- AD711JN £1.97
- AD712JN £2.51
- AD736JN £5.80
- AD797AN £7.25
- AD811N £6.00
- AD812AN £6.32
- AD820AN £3.41
- AD822AN £4.27
- AD829JN £6.41
- AD830AN £5.44
- AD847JN £5.95
- AD9696KN £7.73
- ADEL2020A £5.06
- ADM222AH £3.55
- ADM232AA £3.55
- ADM485JN £2.97
- ADM666AN £2.72
- ADM690AN £5.13
- ADM691AN £6.48
- ADM695AN £6.48
- ADM699AN £3.58
- CA3130E £0.87
- CA3140E £0.63
- CA3240E £0.91
- DG211CJ £1.25
- DG411DJ £2.00
- ICL7106CPL £2.21
- ICL7107CPL £2.72
- ICL7109CLP £5.76
- ICL7611DCP £1.00
- ICL7621 £0.84
- ICL7660SCP £0.80
- ICM7555 £0.48
- ICM7556 £1.04
- L165V £2.26
- L272M £1.21
- L293E £4.20
- L297 £5.12
- L298N £3.80
- L4960 £2.81
- L6219 £4.48
- LF347N £0.41
- LF351N £0.44
- LF353N £0.40
- LF356 £0.52
- LF411CN £1.00
- LM311N8 £0.17
- LM319N14 £0.90
- LM324 £0.20
- LM335Z £1.12
- LM339N £0.18
- LM348N £0.36
- LM35DZ £1.37
- LM358N £0.15
- LM380N £0.90
- LM386 £0.61
- LM392N £1.10
- LM393N £0.17
- LM1881 £2.90
- LM2901N £0.15
- LM2917N8 £1.98
- LM3900N £0.72
- LM3914 £1.90
- LM3915 £2.10
- LM13700 £1.35
- LMC660CN £1.37
- LMC6032IN £1.55
- LP311N £0.74
- LP324N £0.75
- LP339N £0.75
- LT1013CN8 £4.64
- M34-1 £0.30
- M34-2 £0.30
- MAX202CPE £2.00
- MAX208CN £6.99
- MAX220CPE £5.06
- MAX222CPE £5.06
- MAX232CPE £1.30
- MAX483CP £3.13
- MAX485CP £1.50
- MAX631ACP £4.99
- MAX635ACP £4.99
- MAX1232CP £2.80
- MC1458N £0.27
- MC1488 £0.40
- MC1489 £0.35
- MC4558P £0.18
- MK484 £0.66
- NE521N £6.39
- NE555N £0.18
- NE556N £0.24
- NE5532N £0.48
- NE5534N £0.54
- NE5539N £4.35
- OP27CN £2.33
- OP90GP £2.91
- OP97FP £1.84
- OP113GP £3.44
- OP176GP £2.09
- OP177GP £1.76
- OP200GP £5.60
- OP275GP £2.57
- OP282GP £2.27
- OP283GP £5.20
- OP290GP £4.28
- OP297GP £4.64
- OP400GP £11.81
- OP495GP £8.69
- RC4136 £1.00
- SG3524N £0.82
- SG3543 £6.88
- SSM2141P £3.21
- SSM2142P £6.16
- SSM2143P £3.78
- TBA120S £1.04
- TBA800 £0.75
- TBA820M £0.53
- TDA1170S £4.80
- TDA2004 £2.24
- TDA2003V £1.25
- TDA2030AV £1.24
- TDA2050V £2.51
- TDA2611A £1.88
- TDA2822A £0.79
- TDA2653A £2.99
- TED3718DP £5.03
- TEA5115 £3.11
- TL061CP £0.21
- TL062CP £0.21
- TL064CN £0.29
- TL071CN £0.30
- TL072CN £0.20
- TL074CN £0.25
- TL081CN £0.17
- TL082CN £0.32
- TL084CN £0.37
- TL7705ACP £0.82
- TLC271 £0.63
- TS272CN £0.57
- TS274CN £0.50
- TS555CN £0.26
- TMP01FP £5.60
- UA741CN £0.18
- ULN2003A £0.38
- ULN2004A £0.44
- ULN2803A £0.45
- ULN2804A £0.41

EPROM's

- 24LC08BP £0.73
- 27256-200 £3.99
- 27C64A-15F £3.99
- 27C256B-15F £2.42
- 27C1001-15. £3.98
- 27C2001-15. £4.41
- 27C4001-10F £5.98
- 93C46N £0.28

RAM

- GM76C88. £3.60

A/D Converters Data Acquisition

- AD420AN £25.38
- AD7528JN £11.42
- AD7545AK £14.04
- AD7828KN £20.33
- DAC0800 £1.36
- ICL7109CPL £7.75

uControllers

- AT89C2051 £6.38

PIC Series

- 12C508A04P £0.78
- 12C509A04P £0.83
- 16C54C04P £1.49
- 16C54BJW £7.60
- 16C56A-04P £1.56
- 16F84-04P £3.14
- 16F84-10P £4.16
- 16F627-04P £1.95
- 16F627-20IP £2.10
- 17F628-20IP £2.40
- 16F867-04SP £5.10
- 16F877-20P £4.80

Voltage Regulators

- 7805 £0.27
- 7806 £0.29
- 7808 £0.27
- 7812 £0.23
- 7815 £0.23
- 78L05 £0.22
- 78L06 £0.32
- 78L08 £0.22
- 78L12 £0.16
- 78L15 £0.26
- 78L24 £0.39
- 78S05 £0.53
- 78S12 £0.42
- 78S15 £0.32
- 7905 £0.23
- 7912 £0.24
- 7915 £0.22
- 7924 £0.38
- 79L05 £0.20
- 79L12 £0.26
- 79L15 £0.28
- 79L24 £0.30
- ADM666AN £3.44
- L200CV £1.67
- L296 £4.42
- LM2940CT5 £1.08
- LM317LZ £0.25
- LM317T £0.44
- LM317K £2.28
- LM323K £2.40
- LM334Z £0.96
- LM337T £0.64
- LM338K £5.31
- LM338T £1.10
- LM723 £0.40
- LP2950CZ5.0 £0.72
- REF01CP £2.31
- TL431CP £0.14

Diodes

- 1N914 £0.05
- 1N4001 £0.04
- 1N4002 £0.05
- 1N4003 £0.03
- 1N4004 £0.04
- 1N4005 £0.04
- 1N4006 £0.04
- 1N4007 £0.03
- 1N4148 £0.03
- 1N4149 £0.07
- 1N5400 £0.08
- 1N5401 £0.08
- 1N5402 £0.08
- 1N5404 £0.09
- 1N5406 £0.10
- 1N5407 £0.10
- 1N5408 £0.10
- 6A05 £0.27
- 6A1 £0.30
- 6A2 £0.27
- 6A4 £0.28
- 6A6 £0.32
- 6A8 £0.30
- 6A10 £0.35
- BA157 £0.07
- BA159 £0.13
- BAT41 £0.12
- BAT42 £0.07
- BAT46 £0.12
- BAT85 £0.09
- BAV21 £0.07
- BAW62 £0.08
- BAX16 £0.05
- BY127 £0.18
- BY133 £0.10
- OA91 £0.32
- OA200 £0.56
- UF4001 £0.08
- UF4002 £0.08
- UF4003 £0.09
- UF4004 £0.08
- UF4005 £0.10
- UF4006 £0.10
- UF4007 £0.14

Zeners 2.7 to 33V

- 500mW £0.06
- 1.3W £0.10

Bridge Rectifiers

- 1A 50V £0.35
- 1A 100V £0.32
- 1A 200V £0.39
- 1A 600V £0.40
- 1A 800V £0.43
- 1.5A 50V £0.19
- 1.5A 100V £0.11
- 1.5A 200V £0.19
- 1.5A 400V £0.20
- 1.5A 600V £0.24
- 1.5A 800V £0.26
- 1.5A 1kV £0.18
- 2A 100V £0.34
- 2A 200V £0.34
- 2A 400V £0.35
- 2A 800V £0.36
- 2A 1000V £0.45
- 3A 200V £0.34
- 3A 400V £0.40
- 3A 600V £0.33
- 3A 1000V £0.33
- 4A 100V £0.78
- 4A 200V £0.80
- 4A 400V £0.86
- 4A 600V £0.90
- 6A 100V £0.49
- 6A 200V £0.64
- 6A 400V £0.53
- 6A 600V £0.67
- 6A 800V £0.37
- 8A 100V £0.98
- 8A 200V £1.00
- 8A 400V £1.20
- 8A 600V £1.33
- 8A 1000V £1.05
- 25A 100V £1.47
- 25A 200V £1.54
- 25A 400V £1.98
- 25A 600V £1.82
- 35A 100V £1.57
- 35A 200V £1.80
- 35A 600V £1.90
- 35A 1000V £2.32

Potty about Pots!

We now carry in stock a wide range of positive position pots. With either with a centre click or 41 click positions. Log, Lin, Single or Dual gang.

Mixed Packs

- 224 Ceramic Caps £8.50
- 120 Electrolytic Radil Caps £8.50
- 120 Diode & Rectifiers £5.95
- 80 3 & 5mm Mixed LEDs £5.95
- 610 E12 ¼W Resistors £5.75
- 480 E3 ¼W Resistors £4.95
- 100 BC.. Transistors £9.90

Thyristors

- 2N5060 £0.19
- 2N5061 £0.19
- BT151-500R £0.65
- PO102AA £0.30
- TIC106D £0.60
- TIC116D £0.66
- TIC126D £0.77

Triacs

- BT136-500 £0.58
- BT136-600 £0.50
- BT137-600 £0.58
- BT139-500 £1.00
- BT139-600 £1.20
- BTA08-600B £0.84
- BTA08-600BW £0.76
- BTA08-600C £0.96
- BTA08-600SW £0.93
- BTA08-600TW £0.93
- BTA12-600BW £0.92
- BTA16-600CW £1.45
- BTA16-600B £1.28
- BTA26-600B £2.78
- TIC206D £0.84
- TIC206M £0.75
- TIC226D £0.80
- TIC226M £1.00
- TIC246D £1.00
- TIC246M £1.00
- TIC236D £1.12

Diac

- DB3, 32V £0.08

Transistors

- 2N2222A £0.20
- 2N2646 £1.02
- 2N2904A £0.35
- 2N2905A £0.30
- 2N2907A £0.28
- 2N3053 £0.34
- 2N3054 £0.85
- 2N3055 £0.82
- 2N3439 £0.62
- 2N3440 £0.50
- 2N3702 £0.09
- 2N3703 £0.10
- 2N3704 £0.11
- 2N3705 £0.08
- 2N3772 £1.72
- 2N3773 £1.91
- 2N3819 £0.20
- 2N3903 £0.11
- 2N3904 £0.05
- 2N3905 £0.10
- 2N3906 £0.08
- 2N4401 £0.08
- 2N4403 £0.09
- 2N5245 £0.80
- 2N5296 £0.57
- 2N5401 £0.12
- 2N5551 £0.07
- 2N6491 £1.58
- 2N7000 £0.12
- 2SB548 £0.30
- AC187 £0.68
- ACY17 £4.84
- AD161 £0.73
- AD162 £0.95
- BC107 £0.18
- BC107B £0.14
- BC108 £0.18
- BC108B £0.14
- BC108C £0.18
- BC109 £0.24
- BC109C £0.17
- BC114 £0.19
- BC115 £0.41
- BC118 £0.41
- BC132 £0.36
- BC134 £0.36
- BC135 £0.36
- BC142 £0.50
- BC159 £0.17
- BC170B £0.16
- BC177 £0.25
- BC178 £0.18
- BC179 £0.27
- BC182B £0.09
- BC182L £0.11
- BC183L £0.09
- BC184 £0.09
- BC184L £0.13
- BC206B £0.72
- BC208 £0.72
- BC209A £0.72
- BC212L £0.09
- BC214 £0.11
- BC214L £0.10
- BC225 £0.15
- BC237B £0.11
- BC238B £0.11
- BC250A £0.15
- BC261B £0.30
- BC262B £0.24
- BC267B £0.36
- BC319C £0.13
- BC327 £0.08
- BC327-25 £0.08
- BC328 £0.09
- BC337-16 £0.10
- BC337-25 £0.08
- BC348B £0.14
- BC357 £0.25
- BC393 £0.73
- BC461 £0.41
- BC463 £0.29
- BC477 £0.52
- BC479 £0.32
- BC516 £0.21
- BC517 £0.14
- BC546B £0.06
- BC546C £0.08
- BC547A £0.09
- BC547B £0.09
- BC547C £0.10
- BC548A £0.08
- BC548B £0.09
- BC548C £0.08
- BC549B £0.09
- BC549C £0.09
- BC550C £0.11
- BC556A £0.08
- BC556B £0.10
- BC557A £0.09
- BC557B £0.09
- BC557C £0.09
- BC558A £0.08
- BC558B £0.09
- BC559A £0.08
- BC560B £0.13
- BC636 £0.10
- BC637 £0.19
- BC638 £0.21
- BC639 £0.09
- BC640 £0.12
- BCY72 £0.20
- BD124P £6.86
- BD131 £0.48
- BD132 £0.46
- BD135 £0.22
- BD136 £0.21
- BD137 £0.23
- BD138 £0.19
- BD139 £0.19
- BD140 £0.14
- BD150C £0.82
- BD201 £0.40
- BD202 £0.70
- BD232 £0.50
- BD237 £0.32
- BD238 £0.44
- BD240C £0.37
- BD245C £1.10
- BD246C £1.18
- BD283 £0.61
- BD284 £0.61
- BD400 £0.79
- BD437 £0.17
- BD438 £0.22
- BD442 £0.37
- BD534 £0.47
- BD535 £0.50
- BD646 £0.52
- BD648 £0.52
- BDX32 £1.78
- BDX34C £0.45
- BDX53C £0.53
- BDX54C £0.50
- BF180 £0.31
- BF182 £0.31
- BF245B £0.40
- BF257 £0.33
- BF259 £0.33
- BF337 £0.40
- BF422 £0.15
- BF423 £0.15
- BF459 £0.33
- BF469 £0.36
- BFX29 £0.29
- BFX85 £0.33
- BFX88 £0.27
- BFY50 £0.30
- BFY51 £0.22
- BFY52 £0.32
- BS107 £0.21
- BS170 £0.15
- BU208A £1.53
- BU326A £1.40
- BU500 £1.54
- BU508A £1.40
- BU508D £0.98
- BU806 £1.06
- BUT11AF £1.14
- BUX84 £0.78
- BUZ900 £7.68
- BUZ900P £5.74
- BUZ905 £7.68
- BUZ905P £5.55
- IRF530 £0.75
- IRF540 £0.80
- IRF630 £0.42
- IRF640 £0.81
- IRF730 £0.66
- IRF740 £0.91
- IRF830 £0.68
- IRF840 £0.78
- MJ2955 £0.90
- MJ2501 £1.60
- MJ3001 £1.84
- MJ11015 £2.45
- MJ11016 £2.78
- MJE340 £0.33
- MJE350 £0.32
- MPSA05 £0.14
- MPSA13 £0.09
- MPSA42 £0.14
- MPSA55 £0.13
- MPSA56 £0.12
- STP14NF10 £0.49
- STW80NE-10 £3.80
- TIP29A £0.32
- TIP29C £0.33
- TIP30A £0.47
- TIP30C £0.27
- TIP31A £0.23
- TIP31C £0.35
- TIP32A £0.29
- TIP32C £0.30
- TIP41A £0.32
- TIP41C £0.32
- TIP42A £0.47
- TIP42C £0.43
- TIP50 £0.28
- TIP110 £0.28
- TIP120 £0.30
- TIP121 £0.32
- TIP122 £0.37
- TIP125 £0.31
- TIP126 £0.31
- TIP127 £0.37
- TIP132 £0.50
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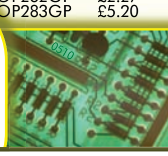

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Firing up the radio

*Most of us use the Internet now, and of course we are all too aware of the extraordinary amount of nonsense and dumbed-down rubbish that passes for content. But, we stick with it because there are 'diamonds' out there too. I found a fascinating website recently that nicely demonstrated engineers' endless inventiveness (**http://tinyurl.com/d526a**).*

Picture this situation; you live in the UK, it's the 1930s and you want to settle down by the gas fire and listen to the radio. Not a problem you'd think, after all, this was the 'golden age of radio'. The only problem is you aren't connected to mains electricity and the radio you have set your heart on is very much a mains-powered unit. What to do? Well, one enterprising Welsh company dreamed up a way to run a 'Gas Operated Radio'; modestly describing it as the invention of a generation! It was essentially a huge array of thermocouples arranged over a gas burner, thereby producing a thermogenerator. I came across this wonderful invention at the online 'Museum of Retro Technology', where you can also browse delights such as the compressed air amplifier, steam driven bicycles and a dog-powered engine.

Although these inventions are great fun, I don't see them presenting much of a threat to modern mains or lithium cell technology. Well, that's not quite true, the thermogenerator does live on in a very hi-tech environment. Look inside some types of spacecraft and you'll find radioisotope thermoelectric generators. These use plutonium to provide a long-lived heat source; the heat comes from radioactive decay and is converted directly to electricity by thermocouples – very handy for outer planet probes, which are much too far from the sun to catch sufficient solar power.

PS – A quick note to all you PIC n Mix fans out there, I am afraid due to Mike Hibbett's work commitments he has not been able to put pen to paper this month. But, rest assured he will be back.

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Email: techdept@epemag.wimborne.co.uk

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We advise readers to check that all parts are still available before commencing any project in a back-dated issue.

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NEWS

A roundup of the latest Everyday News from the world of electronics

3D FEVER SPREADS By Barry Fox

The world is gripped with 3D fever. Cinemagoers are paying extra to see movies in 3D, and Sky is packing pubs with punters watching sports in 3D. Whether people want to watch 3D TV at home remains to be seen. Meanwhile – as always happens with new tech fevers – facts are getting lost in the hype.

Channel 4 added to the confusion with a 3D TV week, using the old anaglyph system. Coloured filters over the eyes separate the left and right images but suck out natural colour.

Broadly speaking, cinemas now use two systems, Real D and Dolby 3D. Both rely on digital projection. Real D puts electronic filters over the projector lens to switch the angle of circular polarisation for the left and right images. The audience wears passive polarising spectacles with oppositely polarised filters.

The glasses are cheap, but the cinema must install a metallised screen to preserve the polarisation; this screen is no good for ordinary 2D because it creates hot spots of light.

Dolby Labs bought in its 3D system from German company Infitec, which spun off from carmaker Daimler Chrysler. A spinning wheel with interference filters over the projector lens sends slightly different red, green and blue frequency spectra to each eye, with rapidly alternating left and right images. The viewer wears passive glasses, with matching colour filters so the left eye sees only the left images, and vice versa. The brain sums the left and right colours to rebuild a near natural colour balance.

The Dolby 3D glasses are very expensive (at least $50) so they must be collected and cleaned for re-use. But an ordinary screen can be used.

Both systems suffer from dim pictures. The filters all block some light.

Sky uses passive polarisation. The left and right images are anamorphically squeezed into an ordinary broadcast picture frame. There are several different ways of doing this, but Sky puts the squeezed images 'side-by-side'. The TV set converts the side-by-side images into an interlaced display, with the left and right images interleaved.

The TV screen is covered with narrow strip polarising filters and the viewer wears passive polarising glasses, which let each eye see only one half of the HD interlace. The result is 'half HD to each eye'.

Panasonic has been vigorously promoting an active shutter system, now adopted as the standard for 3D Blu-ray. The Blu-ray disc uses modified MPEG compression to store the left and right images in Full HD, and a modified Blu-ray player outputs a rapid stream of full HD left and right images for rapid alternate display. The viewer wears active shutter glasses, which alternately blank the left and right eyes in sync with the screen, so each eye sees Full HD.

So far, plasma screens have worked best for active shutter 3D because they can switch images very quickly, but Sony, Samsung and others are using LCDs. DLP projectors can work this way too.

The shutter glasses for one brand of 3D TV will usually not work with a rival brand – and they can cost around £100 each.

In theory, the Dolby/Infitec system could be adapted for home use, but it's not yet been done.

Google announces Google Maps Navigation (Beta) for Android mobile phone users in UK and Ireland

Google has announced the next step for Google Maps for mobile in UK and Ireland – the availability of Google Maps Navigation (Beta) for phones running Android 1.6+.

Google Maps Navigation (Beta) is an Internet-connected GPS navigation or 'satnav' system that provides turn-by-turn voice guidance as a free feature of Google Maps for phones running Android 1.6 and above. The key features include 'Search by voice' to find your destination, the most recent maps, businesses and live traffic from Google Maps, and street-level and satellite views.

Google Maps Navigation (Beta) uses your phone's Internet connection to give you the latest maps and business data. You never need to buy map upgrades or manually update your device because you're always using the most recent data from Google Maps.

Google Maps Navigation (Beta) was built from the ground up as an Internet-connected GPS system, making the following features possible:

Search in plain English – No need to know the address; you can type a business name (eg 'starbucks') or even a kind of a business (eg 'thai restaurant'), just like you would on Google.

Search by voice – Speak your destination instead of typing (English only): 'Navigate to Trafalgar Square in London'.

Traffic view – An on-screen indicator glows green, yellow, or red based on the current traffic conditions along your route. A single touch on the indicator toggles a traffic view that shows the traffic ahead.

Search along route – Search for any kind of business along your route, or turn on popular layers such as petrol stations, restaurants, or parking.

Satellite view – View your route overlaid on 3D satellite views, with Google's high-resolution aerial imagery.

Street View – Visualise turns overlaid on Google's Street View imagery. Navigation automatically switches to Street View as you approach your destination.

Car dock mode – For certain devices, placing your phone in a car dock activates a special mode that makes it easy to use your device at arm's length.

To get Google Maps with Navigation (Beta), search for and download the newest release of 'Google Maps' in Android Market from your Android 1.6+ mobile phone.

Law firm quits illegal file sharing arena

The consumer magazine *Which?* is celebrating after the news that Tilly, Bailey & Irvine Solicitors (TBI) is to stop sending letters accusing people of illegally sharing copyrighted material because the law firm fears the adverse publicity.

Which? received a number of complaints earlier this year from people who had received letters from TBI accusing them of illegally sharing pornography via the internet. The recipients were threatened with legal action unless they agreed to pay £700 in compensation.

After reviewing the letters, *Which?* asked the Solicitors Regulation Authority (SRA) to investigate TBI's conduct, which the consumer champion considered was in breach of the Solicitors' Code of Conduct.

Deborah Prince, Head of Legal Affairs, *Which?*, said: "We're really pleased to hear that Tilly, Bailey & Irvine has seen sense and decided to move out of the volume litigation business. Hopefully, other law firms thinking of going down a similar route will refrain as we believe the practice is inherently unfair and unethical.

"In relation to any alleged illegal file sharing activity, *Which?* favours the proportionate and graduated response advocated by the Digital Economy Bill. We are totally against the practice of scaring people, many of whom are innocent, into making out of court settlements because they fear huge legal bills if the case goes to court."

The SRA is still considering whether any further action against TBI is necessary.

Which? has produced online advice for people who have been accused of illegal file sharing; to view it, visit: **www.which.co.uk/campaigns/file-sharing-fears/index.jsp**

Custom front panel service from Beta LAYOUT

Having pioneered the facility for engineers to purchase PCBs online (**pcb-pool.com**), Beta LAYOUT has announced the introduction of a new online customised front panel service.

This new service enables users to configure their own front panel designs and place an order directly online. As well as providing professional 'free-to-download' design software, numerous machining options, such as material thickness, fonts, colours and finishes are available.

The free, easy-to-use, design software simplifies the configuration and ordering of custom-designed front panels. You can choose from many standardised construction units (for example, ventilators and sub-connectors) which are available in the software's library. The software even calculates the price of the finished front panels for you. Once your front panel design is complete, an order can be placed directly through the software itself.

Alternatively, DXF files from any CAD program can be converted and processed for a small surcharge. Separate printing and inscription files are required for this option.

Various front panel materials can be selected from a wide range of natural or coloured anodised aluminium and plastic (acrylic). Material thickness from 1.5mm to 3mm can be selected. The minimum dimensions possible are 30mm × 30mm, up to a maximum of 300mm × 460mm. High precision CNC machining, such as drilling (with and without threads), countersunk drills, flat milling and cut-outs are all possible. Ultra-modern milling and drilling machines are used to complete the manufacturing process.

The inscription of front panels with text, logos, images and scales is achieved using engraving methods and/or high-resolution digital printing. The maximum order quantity is 50 pieces; lead-times are available from three to eight working days.

For more information, visit: **www.panel-pool.com** or contact via email: sales@pcb-pool.com; or free phone: 0800 389 8560.

Clean up your Mac

Intego, the Mac security specialist, has launched Washing Machine 2, a program that cleans up files left behind by web browsers and other Internet programs. Washing Machine 2, optimised for Snow Leopard (the latest version of the Mac operating system) helps Mac users delete files, which take up space or present privacy risks, created by a number of programs that access the Internet. Users can clean files quickly, manually or automatically, and use secure cleaning to ensure that the files can never be recovered.

Washing Machine 2 can clean five types of items: bookmarks, caches, cookies, download histories and browsing histories. It works with most web browsers, and many utilities or other programs that store information without users being aware. It even cleans up after some programs that users would never think are storing data. These files can take up several gigabytes, and can slow down applications and lead to longer time for backups.

PlaneGadget-Radar

Radargadgets has just released PlaneGadget-Radar, a new low-cost ADS-B receiver at a ground-breaking price that allows enthusiasts to see ADS-B-equipped aircraft plotted on a PC running PlanePlotter virtual radar mapping software.

The PlaneGadget-Radar USB ADS-B receiver has been designed to provide a lower cost alternative for those who can't afford the high price tag of the existing units. The designers' tie-up with PlanePlotter was a key part of keeping the retail price low; by not reinventing their software it was possible to keep down costs to the customer. It also meant using technology (derived from digital STB RF front ends) that is well proven and cost effective.

Data is passed to PlanePlotter in raw packet form. This not only reduces the complexity and cost of the receiver, but also gives PlanePlotter unprecedented access to the detail of all packets received.

The receiver ships with PlanePlotterLite software, developed specifically for the PlaneGadget-Radar. This version is fully functional except that it does not have the networking/sharing facilities. The customer can upgrade to the full version of PlanePlotter via **www.planeplotter.com** to gain this sharing capability for the standard 25 euros (+VAT) price.

The receiver is housed in a small aluminium case measuring just 45mm × 65mm × 30mm, has a USB connection and a female SMA connector for the antenna. Also provided with the unit is an antenna with two metres of coax and a USB lead.

The current receiver is priced at £199 (240 euros) and is available to order direct to the UK and European Union at Radargadgets' website: **www.radargadgets.com.**

A PIC-based Musical Tuning Aid

By JIM ROWE

This compact device will help you tune almost any musical instrument – acoustic or electronic. It can produce any note on the tempered musical scale (standard pitch) in any of the eight most commonly used octaves, with an accuracy of better than ±0.08% or 1.3 musical cents. The selected note is compared with that from the instrument, either by ear, or visually by using an eight-LED stroboscopic beat indicator.

A FEW GIFTED individuals have 'perfect pitch', which allows them to recognise by ear when the note of a musical instrument is accurately tuned (within one musical cent, or 1/100th of a semitone). However, the vast majority, including many musicians, simply don't have this ability or anything like it. For most of us, the only way of tuning an instrument is by comparing its notes with those from tuning forks or some other source of accurately known sound frequencies.

Tuning in

Until about 1970, tuning forks were really the only option. The standard method was to use a single tuning fork at one standard note frequency or 'pitch' (usually A = 440.00Hz). The corresponding note of the instrument was first tuned against this frequency, then the other notes of the octave were tuned against this note using the technique of 'beats' or heterodynes.

This technique involved tuning each note high or low until the audible difference frequency between one of its harmonics and a harmonic of the reference note was correct (for that particular note). Once the notes in the middle octave had been tuned in this way, the corresponding notes

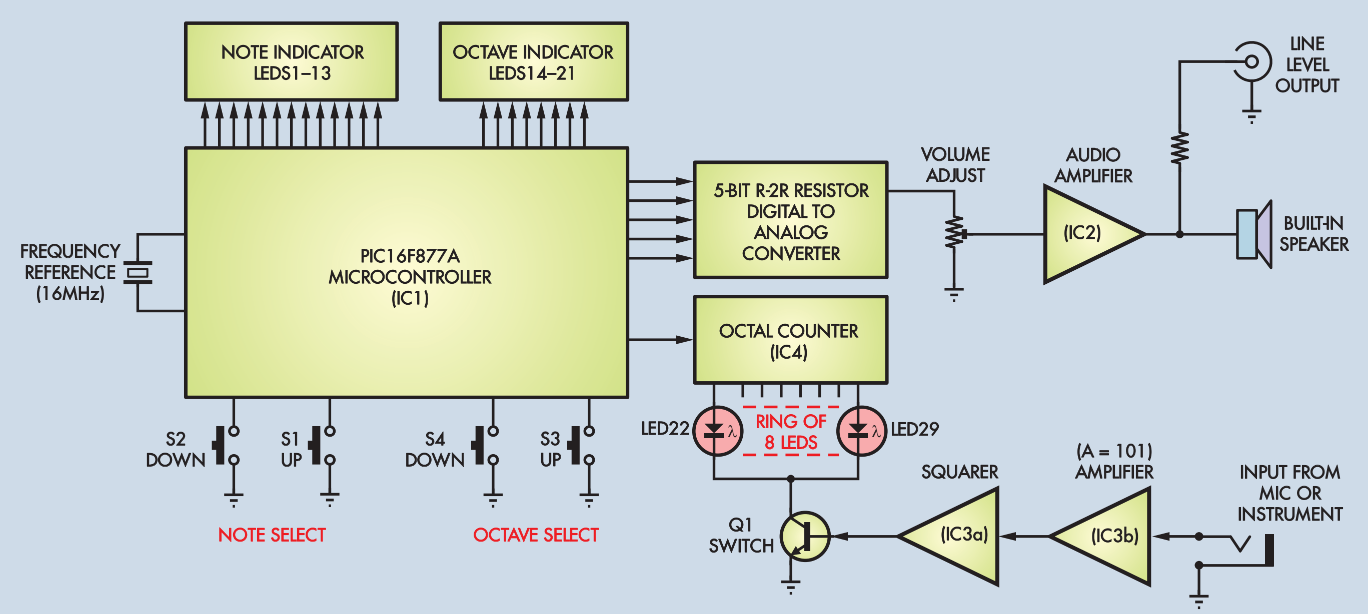


Fig.1: block diagram of the Musical Instrument Tuning Aid. It's based on a PIC microcontroller (IC1) and a 16MHz crystal frequency reference. The PIC divides down the frequency reference and drives a 5-bit DAC (digital-to-analogue converter). This in turn feeds audio amplifier IC2 to deliver the selected tone (set by switches S1 to S4). IC3a, IC3b, IC4 and LED22 to LED29 form a simple stroboscope beat indicator, to enable precise 'visual' tuning.

in the other octaves could be tuned against them by adjusting for a zero beat. It was a pretty tedious business, and required plenty of patience, as well as a good ear.

Instrument tuning became a lot easier in the 1970s when electronic musical tuning aids appeared. In most cases, these aids were based on special ICs known as 'top octave synthesiser' or TOS chips, which had been developed mainly for the second generation of electronic organs.

Inside a TOS chip were 12 or 13 digital frequency dividers, each of which produced one note of the top octave for the organ by dividing down from a shared crystal oscillator (usually around 2MHz). So, by combining a TOS chip with a multi-stage binary divider, it was quite easy to produce a device which could generate virtually any note in any octave, all accurate enough to be used as a tuning reference.

As well as becoming available commercially, a number of these TOS-chip-based tuning devices were described for hobbyist construction in the 1980s. These were very popular because they were much cheaper than the commercial units. However, manufacturers stopped making TOS chips when electronic organ makers didn't need them any more, because they had changed over to designs based on microcontrollers, digital samplers and VLSI devices.

PIC micro

With TOS chips no longer available, the easiest way to produce a musical tuning aid these days is to use a microcontroller. And that's exactly what we've done in designing the 'tuning aid' project described here.

Based on a readily available PIC micro, the Musical Instrument Tuning Aid can produce any note of the tempered musical scale at standard pitch (A = 440.00Hz) and spans the eight most commonly used octaves. All notes are derived from a single crystal oscillator (nominal frequency 16.000MHz) and the frequency accuracy is better than ±0.08% (in fact, much better in many cases).

Since ±0.08% corresponds to about ±1.3 cents, this means that the tuning should be accurate enough even for those with perfect pitch.

Ring of LEDs

The reference notes produced by the unit can be easily used for instrument tuning by ear, because they are fed to an inbuilt amplifier and speaker. In addition, there's a simple 'ring of LEDs' stroboscope, which allows you to tune for zero beats by eye.

To do this, the instrument's note is fed into the unit – either directly or via a microphone – and the instrument's tuning adjusted until the rotating pattern on the LEDs slows down and stops. When the LEDs stop, the instrument is correctly tuned to that note.

The note frequency produced is set using four pushbuttons on the front panel. Two pushbuttons step the selected octave up or down, while another two pushbuttons select the note. In addition, the front panel carries a power on/off switch, plus a screwdriver-access hole to allow an on-board volume trimpot to be adjusted.

Power for the unit comes from either an internal 9V battery or an external 9V to 12V DC supply, such as a car battery or mains plugpack. The circuit is assembled onto a single PC board and is housed, with a 57mm dia. speaker and its battery, in a small UB1-size box.

How it works

Refer now to Fig.1, which shows the block diagram of the Tuning Aid. It's based on a PIC 16F877A 8-bit microcontroller, which does most of the work. The PIC's clock oscillator uses a 16.000MHz crystal, which also serves as the reference frequency.

The main function of the PIC is to generate the desired top octave frequency for whichever note you select, by dividing down from the 16MHz clock. The notes are selected very

Table 1: The 104 Note Frequencies Produced By The Tuning Aid (Hz)

NOTE	OCTAVE 1	OCTAVE 2	OCTAVE 3	OCTAVE 4	OCTAVE 5	OCTAVE 6	OCTAVE 7	OCTAVE 8	ERROR*
C	32.688	65.376	130.751	261.502	523.004	1046.008	2092.016	4184.032	–0.0473%
C#	34.645	69.289	138.579	277.157	554.314	1108.628	2217.256	4434.512	–0.0093%
D	36.680	73.360	146.721	293.442	586.884	1173.768	2347.537	4695.074	–0.0758%
D#	38.867	77.735	155.470	310.939	621.880	1243.760	2487.519	4975.038	–0.0601%
E	41.226	82.452	164.905	329.809	659.619	1319.238	2638.476	5276.952	–0.0521%
F	43.644	87.289	174.577	349.156	698.311	1396.623	2793.246	5586.491	–0.0207%
F#	46.227	92.454	184.908	369.816	739.632	1479.264	2958.528	5917.056	–0.0482%
G	48.980	97.960	195.921	391.843	783.685	1567.371	3134.742	6269.483	–0.0389%
G#	51.909	103.819	207.638	415.275	830.550	1661.100	3322.200	6644.400	–0.0072%
A	55.017	110.033	220.066	440.133	880.266	1760.533	3521.065	7042.131	+0.0303%
A#	58.301	116.602	233.205	466.409	932.819	1865.639	3731.278	7462.555	+0.0527%
B	61.758	123.516	247.031	494.063	988.126	1976.251	3952.502	7905.005	+0.0363%
C'	65.375	130.751	261.502	523.003	1046.006	2092.012	4184.024	8368.048	–0.0474%

*Compared with the notes of the tempered musical scale, at standard pitch (A4 = 440.000Hz). All frequencies are with PIC clock oscillator = 15.9992MHz.

easily and simply by using pushbutton switches S1 (UP) and S2 (DOWN), with the selected note shown clearly by one of LED1 to LED13 (red).

The octave for the desired note is selected in a very similar fashion, using pushbuttons S3 (UP) and S4 (DOWN). In this case, the selected octave is indicated by LED14 to LED21 (green).

Frequency division

Inside the PIC, the selected top octave note frequency is divided down to produce the corresponding note in the selected octave. This division is done in a novel way, as part of the method used to shape the unit's main note output into a reasonable approximation of a sinewave (at least for the lower octaves). This involves using the PIC micro to drive a simple DAC (digital-to-analogue converter) based on an R/2R resistor ladder, with five bits of resolution.

The idea here is that the PIC's EPROM memory stores a set of 256 5-bit samples, corresponding to a single period of a cosine waveform. The PIC reads out these samples from the memory and feeds them in sequence to the DAC, to produce the output note waveform. This is then fed through VR1 to audio amplifier IC2, which drives the speaker.

Now, if the PIC reads out the waveform samples in one-by-one order, it will take 256 of the top octave note pulses to produce a single period of the output note waveform. In other words, there will be an effective frequency division of 256, or 2^8.

This happens to be exactly the right division ratio to produce the bottom-octave equivalent of the selected note.

On the other hand, if the PIC reads out every second waveform sample, it will take only 128 top octave note pulses to generate a single period of the output note waveform. This will, therefore, give the correct division ratio to produce the second-octave equivalent of the selected note.

Similarly, if it reads out every fourth waveform sample, it will take only 64 top octave pulses to produce one period of the output note waveform – giving the correct division ratio for the third-octave note equivalent, and so on.

This is how the frequency division needed to produce the notes in each octave is combined with the 'sample playback' method of producing the output note waveform. This works quite well, producing a good 5-bit approximation of a cosine waveform for all notes in the four lowest octaves. The only catch is that the note waveform becomes more 'steppy' for the highest octaves, where the resolution inevitably drops because we must step through the samples in larger 'jumps'.

As a result, in the fifth octave, the output waveforms have only 4-bit resolution, while in the sixth octave they have only 3-bit resolution. And in the very top octave they have only single-bit resolution – ie, they become square waves.

This diminishing waveform resolution isn't really much of a problem though, because the effective waveform distortion consists almost entirely of odd harmonics – and in many cases only the lowest of these (the third harmonic) will be audible for most adults. This is especially true for the top octave.

Visual tuning

So, that's how we generate the main reference note outputs of the new tuning aid, which are used for instrument tuning by ear. Now let's look at the method used to allow visual tuning, using the 'ring of LEDs' stroboscope.

The stroboscope is very simple, consisting mainly of eight LEDs connected to the outputs of an octal (times-8) counter (IC4). The counter's clock input is driven by an output from the PIC, which provides pulses at a frequency which is a binary multiple of the main note output for the octave concerned. As a result, the counter's outputs cyclically pulse high in sequence, in step with the main note output.

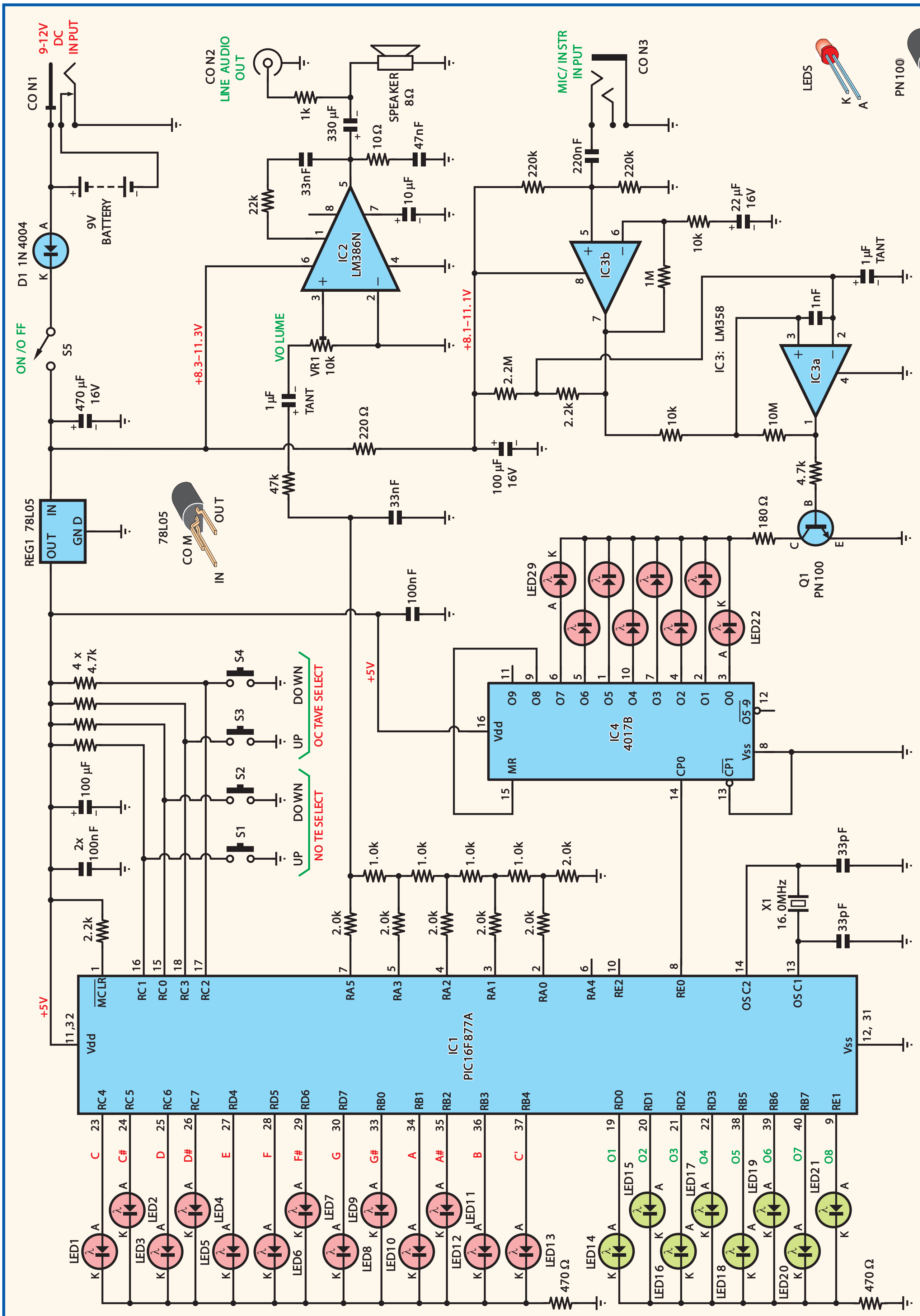
Because the eight LEDs are connected to the counter outputs, this means they can turn on in sequence as the outputs pulse high, provided that transistor Q1 is also on. This transistor is turned on and off using the audio signal from the musical instrument, to control which LED is lit at any instant.

As shown on Fig.1, the signal from the musical instrument is first fed through amplifier stage IC3b, which operates with a gain of about 101. It is then fed through a 'squarer' stage based on IC3a, emerging as a very clean square wave. This is then used to turn Q1 on and off, with the net result that Q1 is turned on for the positive half cycles and off for the negative half cycles of the instrument's note waveform.

So that's how the stroboscope works. As Q1 turns on and off, it (and the octal counter) turns the LEDs on and off as well.

How does this produce an LED pattern that's useful for tuning? Well, consider the situation where octal counter IC4 is fed with a clock signal that's exactly eight times the frequency of the note to which we want to tune the instrument. When the instrument is tuned to a frequency close to that note, Q1 will turn on for a period that's long enough to allow four of the LEDs to light in sequence, ie, during the positive half cycles.

Conversely, Q1 will be turned off for the rest of each note period (ie, during the negative half cycles).



MUSICAL INSTRUMENT TUNING AID

Fig.2: the complete circuit diagram. PIC micro IC1 monitors switches S1 to S4, divides down the 16MHz crystal accordingly and drives LED1 to LED21, which indicate the note and octave selected. IC1's RA0 to RA3 and RA5 outputs also drive a resistive ladder network, which forms the 5-bit DAC. IC4 is wired as an octal counter and is driven by IC1's RE0 output. This counter, in company with op amp stages IC3b and IC3a, make up the zero beat indicator circuit.

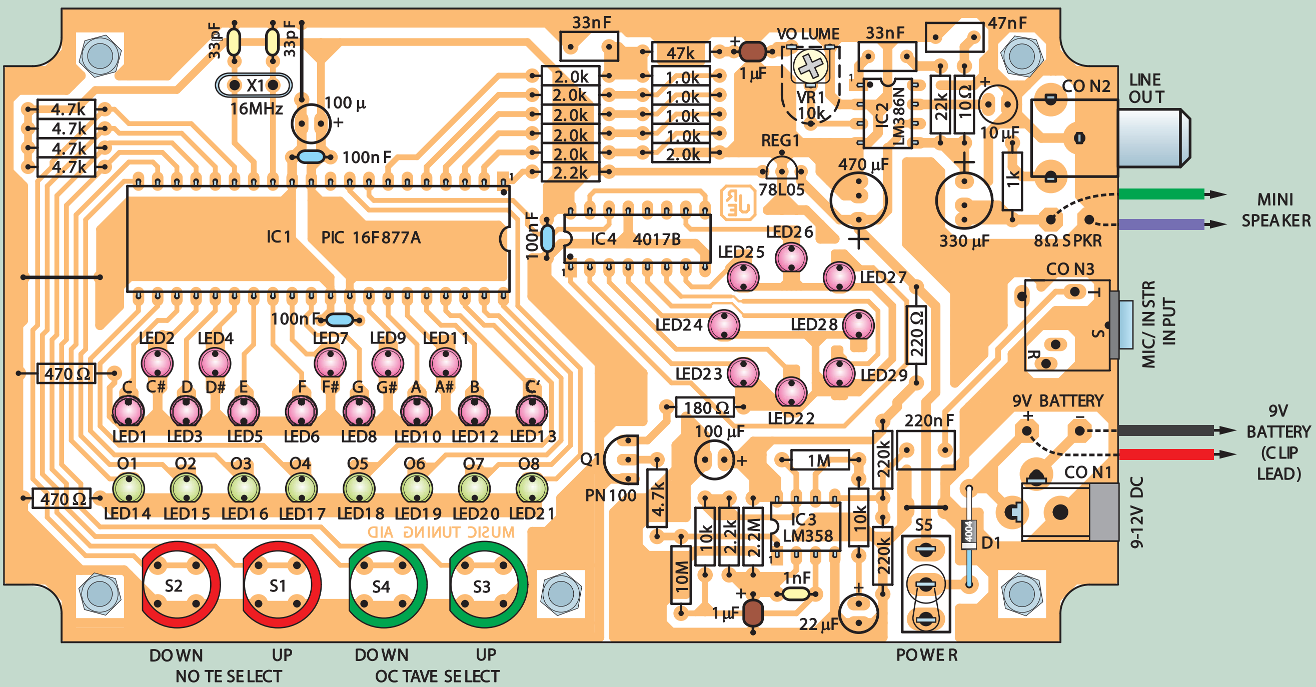


Fig.3: follow this parts layout and wiring diagram to build the unit. Make sure that all polarised parts are correctly orientated and note particularly the orientation of switches S1 to S4 (their flat sides go to the left).

As a result, half the ring of LEDs will light and the other half will remain off. However, unless the instrument note is tuned to the exact note frequency, this 'half on/half off' pattern will rotate either clockwise or anticlockwise, depending on whether the instrument note frequency is too high (*sharp*) or too low (*flat*). So, all you need to do to tune the instrument correctly is to adjust its note up or down in frequency until the pattern rotation slows down and stops.

By the way, the actual pattern displayed on the LEDs depends on the frequency ratio between the strobe counter's clock pulses and the instrument note, and this again varies over the octaves. However, the tuning procedure is always the same: the instrument note is adjusted until the pattern rotation slows down and stops. A stationary pattern indicates 'zero beat' and correct tuning.

Circuit details

Refer now to Fig.2 for the complete circuit diagram of the Musical Instrument Tuning Aid. It uses just four ICs and a handful of other parts.

IC1 is a PIC 16F877A device, chosen because its 40-pin configuration allows very easy interfacing to the control switches, LEDs and resistive ladder DAC. As shown, the 13 note indicator LEDs (LED1 to LED13) are connected directly to I/O pins RC4 to RC7, RD4 to RD7 and RB0 to RB4, and share a common 470Ω current-limiting resistor. The eight octave indicator LEDs (LED14 to LED21) are connected to outputs RD0 to RD3, RB5 to RB7 and RE1 in similar fashion.

In addition, note select pushbuttons S1 and S2 are directly connected to I/O pins RC0 and RC1, together with 4.7kΩ pull-up resistors. Octave select buttons S3 and S4 are connected to RC2 and RC3 in the same way, while crystal X1 is connected between pins 13 and 14.

The resistive ladder network acts as a 5-bit DAC to produce the tuning aid's main note output waveform, and is driven from pins RA0 to RA3 and RA5 of the PIC. A 33nF capacitor is connected across the DAC output to provide a measure of low-pass filtering, after which the note signal is fed via a 47kΩ resistor and a 1μF coupling capacitor to volume control trimpot VR1.

From there, the signal is then fed to IC2, a standard LM386 low-power audio amplifier, which drives an 8Ω mini speaker. Because the low-frequency response of 57mm dia. mini speakers is quite poor, the 33nF capacitor and 22kΩ resistor connected around IC2 are included to provide a small amount of bass boost to improve the audibility of notes in the lowest octave.

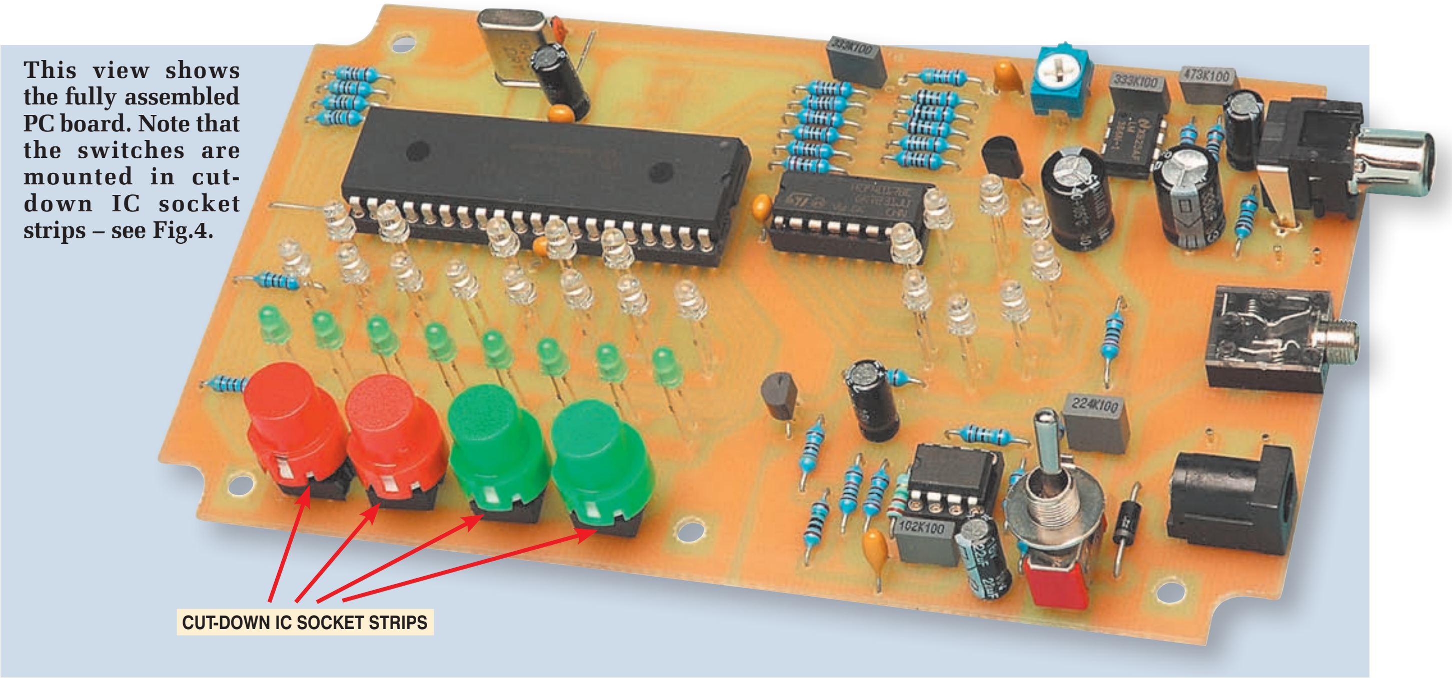
The audio output signal from IC2 is also fed to line output socket CON2 via a 1kΩ isolating resistor. This allows the signal to be fed to an external amplifier if required, or alternatively, to a digital counter or scope if you want to check its frequency or use the signal for other kinds of testing.

Octal counter

IC4 is the counter for the LED stroboscope. This is a 4017B Johnson decade counter with its ninth output connected back to its reset input to configure it as an octal counter. LED22 to LED29 are connected to outputs O0-O7, while the counter itself is fed strobe clock pulses from the RE0 pin of the PIC (IC1).

The note signal from the instrument being tuned (or from a microphone picking up the sound) is fed into the circuit via CON3, a 3.5mm jack socket. It is then fed to op amp IC3b (LM358), which is wired with a gain of 101, as determined by its 1MΩ and 10kΩ feedback divider resistors.

From there, the amplified signal at pin 7 is fed to IC3a, which is configured as a comparator with positive feedback, so it becomes a Schmitt trigger 'squarer'. This stage converts the signal from IC3b into a clean square wave. This is then fed to the base of transistor Q1 via a 4.7kΩ resistor, to switch it (and the strobe LEDs) on and off.



This view shows the fully assembled PC board. Note that the switches are mounted in cut-down IC socket strips – see Fig.4.

As stated earlier, power for the circuit comes from either an internal 9V battery or an external 9V to 12V DC supply (fed in via CON1). Diode D1 provides reverse polarity protection, while S5 is the on/off switch.

REG1 provides a regulated +5V supply rail for IC1 and IC4, while IC2 runs directly from the unregulated input supply. IC3 runs from this same unregulated supply via a decoupling circuit consisting of a 220Ω resistor and a 100μF capacitor.

Note that the battery is automatically disconnected from the circuit when an external supply is plugged into CON1.

Software

The software files are available via the EPE Library site, accessed via **www.epemag.com**. Pre-programmed PICs will also be available from Magenta Electronics – see their advert in this issue for contact details.

Construction

Apart from the battery and mini speaker, all of the parts are mounted on a single-sided PC board, measuring 147mm × 84mm. This board is available from the *EPE PCB Service*, code 756.

The board has rounded cutouts in each corner so that it fits inside a standard UB1-size plastic box. It is attached to the rear of the case lid via five M3 × 15mm tapped spacers.

The three input/output connectors are all mounted at the right-hand end of the board, while the LEDs, pushbutton switches S1 to S4 and power switch S5 all protrude through matching holes in the lid.

Note that connectors CON1 to CON3 all mount directly on the top of the PC board, as does switch S5. However, pushbutton switch S1 to S4 are not tall enough to mount directly on the board, and so must be plugged into spacer sockets made by cutting down a couple of 14-pin DIL IC sockets (more on this later).

Fig.3 shows the component layout on the PC board. Here is the suggested order of assembly:

1) Fit the three wire links to the board, followed by the PC board terminal pins for the battery and speaker connections. These terminal pins should be fitted from the underside (copper side) of the board, because the wires to be soldered to them later are under the board.

2) Install connectors CON1, CON2 and CON3, then fit the sockets for IC1, IC3 and IC4, making sure you orient each of these as shown in Fig.3 (to guide you later when it comes to plugging in the ICs). Note that a socket is not used for IC2; this is soldered directly to the board (later), to ensure stability.

3) Install the resistors, making sure that you fit each one in its correct position. Follow these with the volume trimpot (VR1).

4) Fit the disc ceramic, monolithic and MKT metallised polyester capacitors (these can go in either way around), then fit the tantalum and electrolytic capacitors. Note that the tantalums and electrolytics are all polarised, so be sure to fit them with the correct orientation.

5) Fit diode D1, regulator REG1, transistor Q1 and finally IC2. Be sure to install each of these with the orientation shown on the overlay diagram.

6) Now fit all of the LEDs. These are all fitted vertically, with the lower end of their bodies spaced 13mm above the board (so that they will just protrude through the holes in the box lid when the board is later mounted behind it).

The easiest way to do this is to cut a strip of thick cardboard to a width of 13mm, and then use this cardboard strip as a spacer between each LED's leads while it is soldered into position. In practice, the cardboard strip can be left under each horizontal row of LEDs until they are all soldered in place and then withdrawn to be used for the next row of LEDs. It can also be used when you're fitting the 'ring of LEDs' (LED22 to LED29).

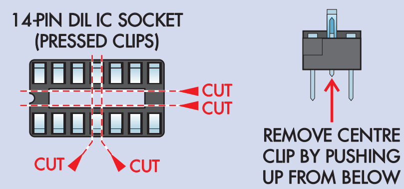


Fig.4: the socket strips for pushbutton switches S1 to S4 are made by cutting eight 3-pin strips from two low-cost 14-pin IC sockets, then removing the centre pin from each strip.

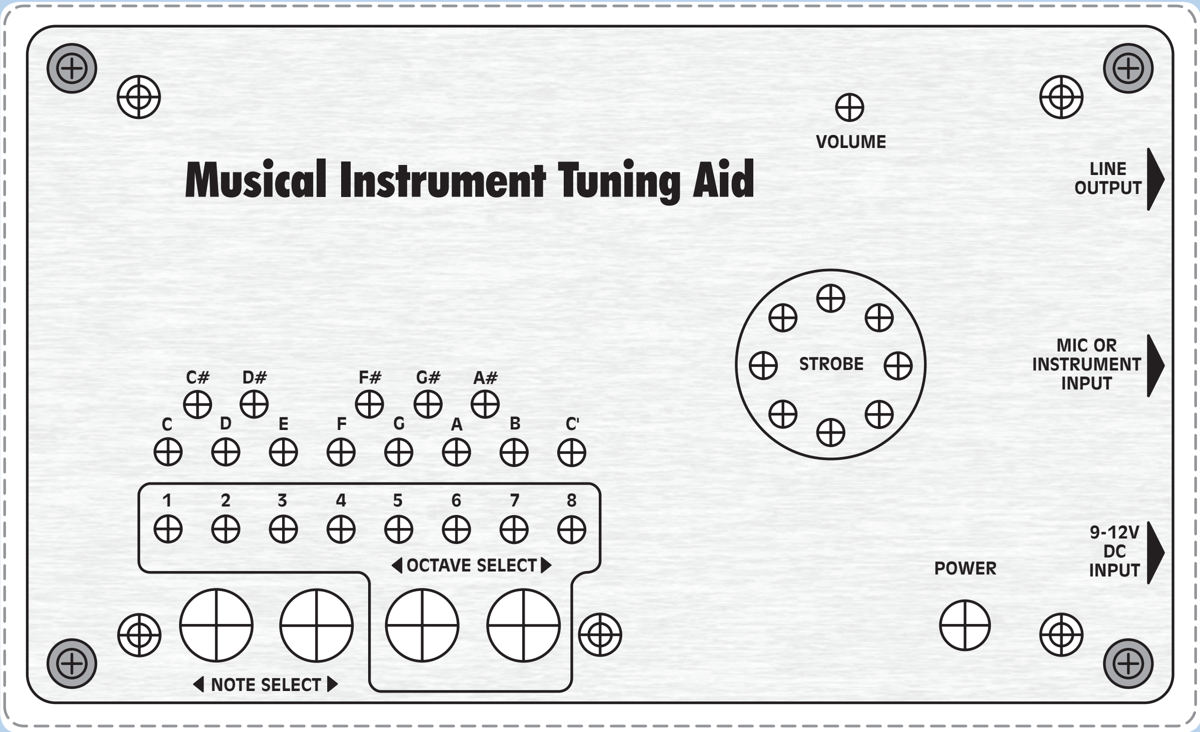


Fig.5: this full-size artwork can be copied and used as a drilling template for the front panel.

7) Next on the list are the spacer socket strips for pushbutton switches S1-S4 (necessary to ensure they protrude through the matching holes in the box lid). These spacer strips are cut from low-cost 14-pin IC sockets. Fig.4 shows how these strips are prepared.

   Each switch is mounted on two 3-pin sections cut from one side of a 14-pin socket, but with the centre pin of each section pushed out and discarded. Note that only the spacer strips are soldered to the PC board. The switches then plug into them

8) Now fit crystal X1, toggle switch S5 and the five M3 × 15mm tapped spacers, which are used to attach the board assembly to the rear of the case lid. These spacers are attached to the board using M3 × 6mm pan-head screws and washers, while similar screws with countersink heads are used later to attach the spacers to the lid.

9) Complete the board assembly by plugging IC1, IC2, IC3, IC4 and the switches into their sockets. **Be sure to orientate the ICs and the flat sides of the switches as shown in Fig.3.**

Preparing the box

Unless you're building the Music Tuning Aid from a kit, you will now need to prepare the case by drilling the required holes. A photocopy of the front panel artwork (Fig.5) can be used as a drilling template for the lid.

The holes for switches S1 to S4 should be drilled or reamed to 10mm diameter, while the hole for S5 should be 6.5mm in diameter. All of the holes for the LEDs should be 3.5mm, as should the adjustment hole for the volume trimpot. The spacer screw holes are also drilled 3.5mm, but countersunk on the top.

Another three holes are drilled in the right-hand end of the box, to allow access to the three input-output connectors. The locations and diameters of these holes are shown in Fig.6.

Finally, you will have to drill two 3mm holes in the bottom of the case for the battery clamp screws and a pattern of holes to allow the sound from the speaker to escape. In the latter case, it's simply a matter of drilling an array of 5mm holes inside a guide circle 43mm in diameter. Position this guide

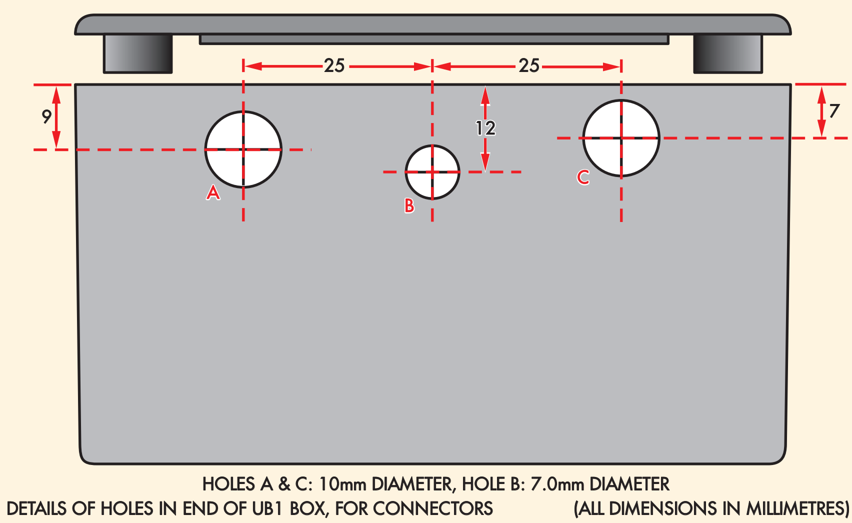


Fig.6: this diagram shows the drilling details for the right-hand side panel.

Parts List – Musical Instrument Tuning Aid

1 PC board, code 756, available from the *EPE PCB Service*, size 147mm × 84mm
1 UB1 plastic utility box, size 158mm × 96mm × 53mm
1 57mm dia. 8 ohm mini speaker
2 PC-mount momentary pushbutton switches, red (S1,S2)
2 PC-mount momentary pushbutton switches, green (S3,S4)
1 mini toggle switch, SPDT (S5)
1 16.000MHz crystal, HC49U/US case (X1)
1 PC-mount 2.5mm DC power connector (CON1)
1 PC-mount RCA phono socket (CON2)
1 PC-mount 3.5mm mini jack socket, (CON3)
5 M3 × 15mm tapped spacers
5 M3 × 6mm machine screws, countersink head
5 M3 × 6mm M3 machine screws, pan head
1 40-pin IC socket
1 8-pin IC socket
1 16-pin IC socket
2 14-pin IC sockets (see text)
4 self-adhesive rubber feet
1 9V battery clip lead
4 PC board terminal pins, 1mm diameter
2 150mm lengths of insulated hookup wire
1 10kΩ horizontal PC-mount mini trimpot

Semiconductors
1 PIC16F877A pre-programmed microcontroller (IC1),
1 LM386N audio amplifier (IC2)
1 LM358 dual op amp (IC3)
1 4017B CMOS counter (IC4)
1 78L05 +5V regulator (REG1)
1 PN100 NPN transistor (Q1)
21 3mm red LEDs (LED1 to LED13, LED22 to LED29)
8 3mm green LEDs (LED14 to LED21)
1 1N4004 diode (D1)

Capacitors
1 470µF 16V radial electrolytic
1 330µF 16V radial electrolytic
2 100µF 16V radial electrolytic
1 22µF 16V radial electrolytic
1 10µF 16V radial electrolytic
2 1µF 25V tantalum
1 220nF MKT metallised polyester
3 100nF multilayer monolithic ceramic
1 47nF MKT metallised polyester
2 33nF MKT metallised polyester
1 1nF disc ceramic
2 33pF disc ceramic

Resistors (0.25W 1%)

1 10MΩ	2 2.2kΩ
1 2.2MΩ	6 2kΩ
1 1MΩ	5 1kΩ
2 220kΩ	2 470Ω
1 47kΩ	1 220Ω
1 22kΩ	1 180Ω
2 10kΩ	1 10Ω
5 4.7kΩ	

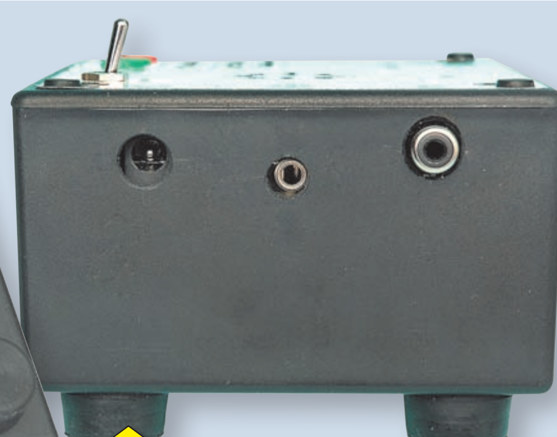
circle centrally in the left half of the case bottom.

Once these holes have been drilled and deburred, clamp the battery into position and glue the speaker in place. The U-shaped battery clamp can be made from a piece of scrap aluminium and is secured using two M3 × 6mm screw, nuts and lock washers.

The speaker can be secured using five or six small dobs of epoxy cement around the rim of its frame. The case should then be placed aside for the epoxy cement to cure overnight.

The final step in preparing the box lid is to fit the front-panel label. First, print out the artwork on an adhesive-backed label, and then apply a rectangle of clear 'Contac' or similar adhesive film to the front to protect it from scratches and finger grease. The label is then trimmed to its correct size and the corner holes removed using a sharp hobby knife, to provide a guide when you're positioning it on the lid.

Once it's attached to the lid, the remaining holes can be cut out using either a sharp hobby knife or a hole



Above: the three holes in the end of the case provide access for the DC input socket (left), the mic/instrument socket and the line output socket.

Left: a pattern of holes is drilled in the bottom of the case beneath the loudspeaker mounting position, to allow the sound to escape.

punch (a hole punch will do a much neater job).

Final assembly

The PC board assembly can now be attached to the back of the lid and secured using M3 × 6mm countersink head screws. Ensure that all the LEDs and switches go through their mounting holes before doing up the screws.

Note that one of switch S5's nuts is removed before fitting the board and then refitted to the switch when the board is in position. Don't tighten it down too much, otherwise the panel label may buckle and tear. The switch nut on the underside can be wound up to the bottom of the lid to help prevent this.

The next step is to solder two 150mm lengths of light-duty hookup wire to the speaker terminals. The other ends of these wires are then soldered to the relevant PC stakes underneath the PC board (near CON2). The 9V battery clip leads are connected to the other two terminal pins, between CON3 and CON1. Note that the black lead must connect to the outermost of these pins (–), while the red lead connects to the innermost pin (+).

That completes the assembly of the Musical Instrument Tuning Aid. Now for the check-out procedure.

Check-out time

Before applying power, adjust volume trimpot VR1 so that it is about 30° clockwise from its fully anticlockwise position. That done, connect the battery snap lead and switch on.

Because the PIC's program is set to deliver a default output note of A = 440Hz, you should immediately be greeted by a tone of this frequency from the speaker. At the same time, the red 'A' note LED (LED10) should light, along with the 'octave 4' green LED (LED17).

If nothing happens, the odds are that you have reversed the battery clip lead connections at the PC board or diode D1 is in the wrong way around.

Assuming it works so far, try changing the note by pressing either S1 or S2 (red). Each time you press one of these buttons, the note produced by the Musical Instrument Tuning Aid will step up or down by a semitone – until you get to the upper or lower limit.

Similarly, pressing switches S3 or S4 (green) should step the tone frequency up or down through the octaves.

Strobe check

To check the operation of the beat stroboscope, first reset the unit's output to A = 440Hz. This can be done either by using the pushbutton switches to return to this note and octave or by simply switching the unit off and then waiting a second or two before turning it on again (to get the note by default).

Now feed a 440Hz (approximately) audio signal into the unit via CON3. This should preferably come from an audio oscillator, so you can easily vary its frequency.

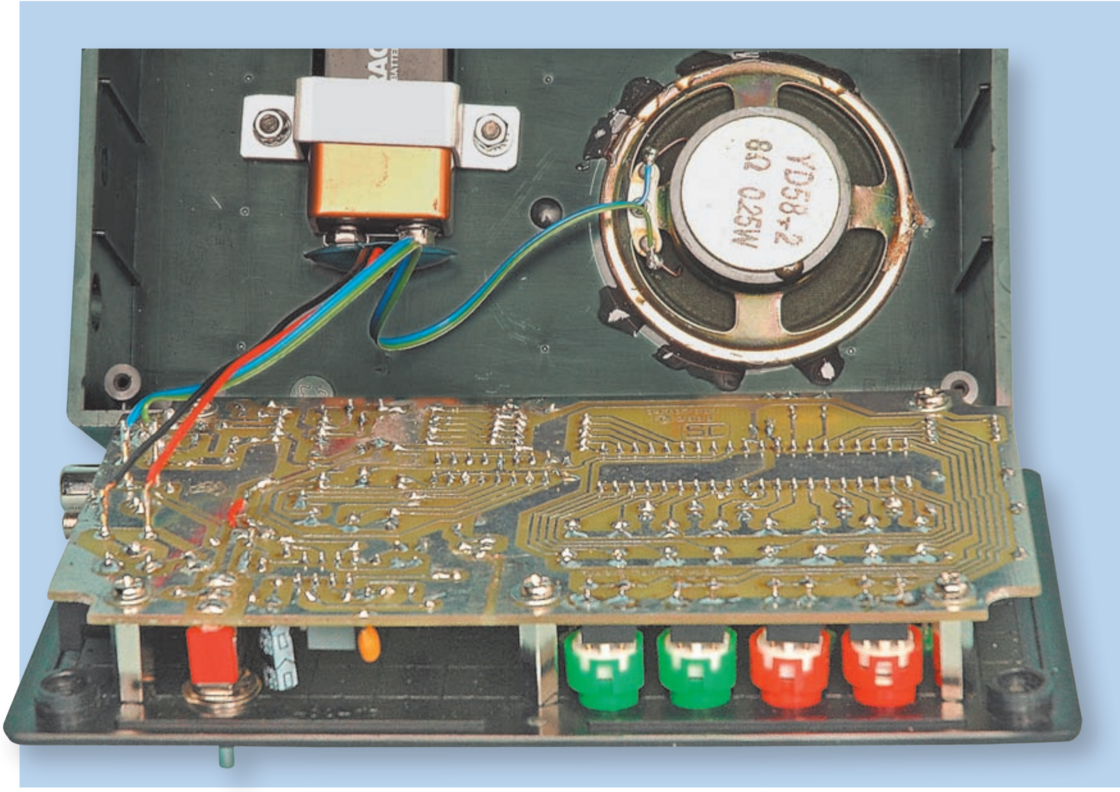
As soon as this external signal is applied, four or more of the stroboscope's ring of LEDs (LED22 to LED29) should light. If the signal frequency is not very close to 440Hz, they will probably all appear to be continuously lit.

However, if you now carefully adjust the input signal frequency to approach 440Hz, only four of the strobe LEDs should light at any time. In addition, this semicircle of light should rotate – either clockwise or anticlockwise.

As you adjust the frequency closer to 440Hz, the speed of rotation will slow down. In fact, it will stop rotating altogether when the two frequencies are equal. If you then keep adjusting the signal's frequency 'out the other side', the stroboscope LEDs will begin rotating in the opposite direction, slowly at first and then faster as the frequencies move further apart.

If all of this happens as described, your Musical Instrument Tuning Aid is working as it should and the assembly can be fastened into its box. At the same time, you will have seen just how easy it is to use the ring of LEDs stroboscope to achieve exact 'zero beat' tuning of the notes from virtually any musical instrument.

It's simply a matter of setting the unit to the note concerned and then adjusting the instrument until the strobe LEDs stop rotating. ***EPE***



The PC board is fitted with five tapped spacers and secured to the lid using machine screws. A clamp fashioned from scrap aluminium secures the battery, while the speaker is secured using a few dabs of epoxy resin.

TechnoTalk

Spiral Madness?

Mark Nelson

There's something about spirals that lead us out of sanity, especially when they may represent a grotesque electronic experiment that is out of control. Mark Nelson investigates the strange world of electroatmospheric effects.

The spiral motif has appeared in mystery films for 70 years or more, a kind of shorthand for indicating anything weird or of a vaguely threatening nature. A prime example was the science fiction TV programme *The Time Tunnel*, in which a swirling vortex engulfed the key character in each episode.

In that particular scenario, it was the costs of a fictional US government weapons project that was spiralling out of control. But the truth is often stranger than fiction, and now a US government project is spiralling out of control for real, allegedly.

Tampering with nature

Applied science has many beneficial effects, even if some research fields are somewhat controversial. You doubtless have your own ideas about genetically modified foods and atomic energy, but what about deliberate tampering with the Earth's atmosphere? Precisely this, it is argued, is what the Americans are doing, not on their own patch but in Norway. We'll return to this later, but first let's examine this spiral business, specifically the 'Norway Spiral' of 9 December last year.

What took place in the night sky was one of the most spectacular phenomena, described as a giant blue corkscrew spiral hanging in the air for 10 to 15 minutes, never dissipating or fading until after it opened out into a curious, perfectly round 'black hole' shape. Towards the end of this stunning light show, a blue-green shaft of light was reported to have beamed out of the centre of the spiral.

Widely observed, many people commented that it appeared to emanate from a single bright point on the ground, seemingly as if some kind of massive projection system were beaming it up into the sky. You can see the pictures for yourself if you search Google Images for 'Norway Spiral'. So, what on earth was going on?

Catastrophic

The official explanation was that a Russian intercontinental ballistic missile failed at the third stage after being test-fired from a submarine in the White Sea. The spirals could have been created by a missile tumbling through the air and leaking fuel, it was stated. Since then, there has been little comment from official sources, but conspiracy theorists have not held back with their opinions.

The *Pakistan Daily* was not in any doubt on 8 January when it quoted Russian reports that a high-energy beam had been fired into the sky from the US high frequency active auroral research program (HAARP) radar facility in Ramfjordmoen, Norway. What's more, this had resulted in a 'catastrophic puncturing' of the planet's thermosphere, thus allowing an 'unimpeded thermal inversion' from the outermost layer of Earth's atmosphere into the troposphere, or 'weather layer' of the atmosphere. This in turn put the entire northern hemisphere at risk of suffering abnormally low temperatures.

Inconsistencies

Stirring stuff, but the Ramfjordmoen facility does not belong to the US, which rather 'punctures' this theory. Instead, it is operated by EISCAT, the European Incoherent Scatter Scientific Association, which is funded and operated by research institutes in Europe, China and Japan. EISCAT operates an ionospheric heater (similar to the HAARP system) facility at Ramfjordmoen, but has not commented on these allegations. So could the spiral have indeed been caused by a missile failure?

Not at all, according to David Wilcock, who asks: "If it were indeed a missile, how was it simultaneously creating a perfectly circular spiral that was white, while also maintaining the blue corkscrew formation at the same time?

The 'missile' doesn't release any other gases, of any colour, in any other direction. Just white, in a perfectly concentric series of spirals, and blue in a bizarre corkscrew spiral that never went away until the whole thing spread apart and disappeared. If the spiral was caused by a missile from the White Sea, as the conventional explanation insists, it would have to be rotating at more than twenty miles per second!"

A HAARP that angels don't play

HAARP was mentioned a moment ago without any explanation, so what's all this about? HAARP is a US government programme to investigate physical and electrical properties of the Earth's ionosphere that can affect military and civilian communication and navigation systems. It is best known for its ionospheric research facility located in Gakona, Alaska – and for the controversy that surrounds the ethics of this programme.

The technical installation comprises an antenna farm of 180 beams on a land area of about 35 acres, along with transmitters having a total radiated power capability of a massive 3.6MW. This energy is beamed directly upwards into the ionosphere, where it causes heating and ionisation.

According to the official website (**www.haarp.alaska.edu**), this has no harmful effects as the ionosphere is a turbulent medium that is constantly 'stirred up' and renewed by the sun, meaning that any artificially induced effects are obliterated quickly. And since the ionospheric storms caused by the sun itself do not affect the weather on Earth, there is no chance that HAARP would do so either.

Military mission?

This benign view is not held by all, however. HAARP publicity gives the impression that the programme is mainly an academic project, whereas US military documents put it more clearly: HAARP sets out to learn how to 'exploit the ionosphere for Department of Defense purposes'.

According to Dr Nick Begich, HAARP could provide the military with a tool to replace the electromagnetic pulse effect of atmospheric thermonuclear devices; replace ELF submarine communication systems with a new and more compact technology and replace over-the-horizon radar with a more flexible and accurate system. It could also provide wide-area earth-penetrating tomography and become a tool for geophysical probing to find oil, gas and mineral deposits over a large area. He continues by stating that heating the ionosphere could produce controllable global communication disruptions, weather modification and even wide-area mind control.

What he does not explain is why the United States might wish to deploy such lethal techniques of environmental warfare, techniques that could well be self-destructive. All the same, his co-authored book *Angels Don't Play This HAARP* makes a fascinating read for those who enjoy way-out conspiracy theories.

And finally…

So, after all this, what was the Norway Spiral? Was it man-made or a natural phenomenon? Surprisingly, it was neither, as a poster on the Internet message boards make clear. 'Silvie' states with authority, 'The blue ray represents Orgone and so does the spiral. Orgone energises the body and also protects us from chemical trails and EMF. Orgone energy is the energy of the life force.' Or, according to 'Nova Doba', 'It is a sign heralding the imminent appearance of Maitreya, the World Teacher. The 'star' is really one of four enormous spacecraft placed around the world.'

Normal service will be resumed as soon as possible.

Part.3: By JOHN CLARKE

Water Tank Level Meter: Telemetry Base Station

Designed to work with up to 10 Water Tank Level Meters, this Base Station lets you monitor water levels from a remote location (eg, inside your home). As a bonus, it also includes an option for electric pump control.

THE ability to monitor water tank levels from a remote location can be very useful in certain circumstances. This is particularly true if you have several water tanks or if the tanks are hard to access, or you want to include automatic pump control.

This Base Station is intended for use with the telemetry version of the Water Tank Level Meter described in the April and May 2010 issues of *EPE*. It has an inbuilt 433MHz wireless receiver module and can handle data transmissions from up to 10 level meters and display the results on a 2-line 16-character LCD module. In bargraph mode, it can show up to 10 tank levels simultaneously, while the digital readout mode shows individual tank levels to 1%.

As shown, the Base Station is a compact unit that can be placed on a shelf or a desk, or attached to a wall via integral mounting brackets. The display is backlit so that it can be readily seen under all lighting conditions.

The only controls are four pushbutton switches situated in a line immediately below the LCD module. These are used to control the display format and to set up pump control. Power for the Base Station comes from a 9V DC 200mA plugpack.

Display format

As mentioned, the display can be switched to operate in one of two formats. The first shows all enabled tanks and their levels as an 8-level bargraph on the one display ('All Tanks View' diagram). In this format, the top line shows the word 'LEVEL' and the tank levels are displayed as a rectangular tank with sides.

Each tank level is shown by the height of the bars in the tank and each bar corresponds to a 12% or 13% step in level. So, for example, with only the bottom bar showing, the level is above 12%. For two bars the level is above 25%, while four bars represents a level above 50%.

If the tank is full (ie, at 100%), the tank symbol is just a full rectangular block (ie, all bars are on). Conversely, an empty tank or one that is below 12% in level shows an 'e' for empty.

The second line in the display shows the word 'TANK' and the number of each tank is displayed directly beneath each of the tank level bargraphs. As mentioned last month, each Water Tank Level Meter is assigned a tank number using a 0-9 BCD rotary switch. These selected numbers are the ones that are displayed for each tank.

Note that only the tanks that are monitored with a Water Tank Level

Meter need to be shown on the display. So, if you only are monitoring Tank 1 for example, then that number is all that needs to be displayed.

Basically, you can enable which tank numbers the display will show. If only five tanks are enabled, and they utilise numbers from 1-5, then each consecutive number will be separated by a space. If there are more than five tanks or if numbers above five are used, then there is no space between each consecutive tank number on the display.

In practice, the tanks are displayed from left to right in a 1-9 and then 0 sequence. However, if one or more of these tank numbers is not enabled, then the display will include a space where the tank number would otherwise be positioned.

View switch

Pressing the View switch accesses the alternative digital display format ('Individual Tank Detail' diagram). In this mode, individual tank data is shown. For example, if tank 1 is selected, the first line will show: 'TANK1', followed by 'LEVEL' and then the water tank level value as a percentage. For example, it may show '27%'. The levels can range from 0 to 110%.

If no tanks are enabled in this mode, the display will show 'TANK ERROR ENABLE A TANK!' (we describe how to do this a bit further on).

The second line in this display format shows the temperature reading in °C, and this can range from –99°C through to +99°C (this is the temperature inside the corresponding Water Tank Level Meter). Following this is the word 'CELL' and then the cell voltage (eg, 1.21V).

If the cell voltage is below 1.15V, then a small cross will be displayed just before the voltage value. This indicates that the cell in the level meter is not charging correctly, which may soon prevent it from operating.

Each enabled tank can be checked in sequence using the Up (▸) or Down (◂) switches to select the tank number required. Note that only enabled tanks will be displayed. For example, if you have enabled tank 1, tank 3 and tank 4, then the Up switch will cycle as: 1, 3, 4, 1, 3, 4. Similarly, the Down switch will cycle between these numbers in the reverse sequence. Note that if you have only enabled one tank, then the Up and Down switches will have no effect.

Data for the Telemetry Base Station is transmitted from one or more Water Tank Level Meters (up to 10), as described in the April and May 2010 issues of *EPE*.

If the base station has not received any data from the selected Water Tank Level Meter then it will show a question mark (?) in the space that normally shows tank level. In greater detail, this will be shown in place of the bargraph for the 'All Tanks View' mode and in place of the the level and temperature value portions for the 'Individual Tank Detail' format.

In addition, a '?' is initially displayed for level, temperature and cell voltage when the Base Station is switched on, before it receives data from the Water Tank Level Meter. The '?' will reappear after data for that particular tank has not been received for more than an hour. However, the cell voltage will still be displayed and will show the last measured voltage before transmission was lost.

Loss of reception for over an hour can mean that the Water Tank Level Meter has a low cell voltage and has ceased transmitting. The last measured cell voltage before data was lost can

Typical Base Station Display Readings

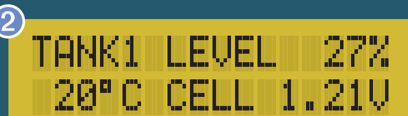
1

(1). The 'All Tanks View' format gives a graphical view of all enabled tanks and their contents.

3

(3). Pressing the Set switch brings up the tank options. This is the display if a tank is not enabled.

2



(2). The alternative 'Individual Tank Detail' format shows detailed data for each tank in digital format.

4

(4). The unit can be programmed to separately control up to 10 pumps, turning them on or off at set levels.

Feature and Specifications

Features

Monitors up to 10 Water Tank Level Meters

Digital readout shows 1% level resolution for individual tanks

Switchable bargraph level display for monitoring all tanks simultaneously

Temperature and cell voltage monitoring for each tank meter

Can automatically control up to 10 electric pumps

Automatic pump-off switching with water level and temperature

Water level threshold adjustment for pump off

Temperature threshold adjustment for pump off

Specifications

Number of tanks monitored: 10 maximum

Bargraph display: eight levels plus 'e' for empty, corresponding to levels of 0, 12, 25, 37, 50, 62, 75, 87 and 99%

Individual display: percentage display from 10-110% in 1% steps; temperature from –99°C to +99°C.; cell voltage with 2-digit 10mV resolution

Pump Control: up to 10 pumps

Temperature threshold: pump switches off for temperatures below the setting from –9°C to +99°C; adjustment can be made in 1°C steps.

Level threshold: pump switches off for level settings below 50%. Alternatively, pump switches on for level settings above 50%. Adjustment is available in 1% steps from 0-100%

Invalid data: displays shows a '?' if no valid data at power up and after one hour without fresh data.

Power: 9V to 12V DC @ 100mA

Encode: 16 selections to help prevent reception of a neighbouring signal

help solve the problem. Cell voltages at or below 1.10V reveal that the cell is discharged.

Alternatively, the Water Tank Level Meter could have met with a much more catastrophic disaster!

Enabling a tank

As noted earlier, a tank must be enabled for the Base Station to display its data. To do this, you first press the Set switch so that the tank options are displayed. If a tank is not enabled, the display will show, for example, <TANK1>OUT on the top line.

To select the required tank number, you press the Up (▶) switch to successively select numbers 3, 4, 5, 6, 7, 8, 9, 0, 1, 2... That done, you enable the selected tank by pressing the Down (◀) switch. This changes the display so that it now shows the PUMP ON or OFF indication and settings on the second line of the LCD.

Once a tank has been enabled, you can continue to enable more tanks by pressing the Up switch (S4) to find the tank number and then the Down switch (S3) to enable the tank as required. That done, it's just a matter of pressing the View switch (S1) to return to the main display format.

Pump control

Once a tank has been enabled, the menu for its pump control can be displayed by pressing the Set switch (S2). The display then shows various options for controlling an electric pump associated with that tank.

Do note that the pump number for a particular tank is the same as the tank number; ie, a pump associated with tank 1 is pump 1, a pump associated with tank 2 is pump 2, and so on.

Initially, when a tank is first enabled, the pump is set to OFF. To turn the pump on, first press the Set switch to display <OFF> following the word PUMP. The setting is then changed from OFF to ON by pressing either the Up (▶) or Down (◀) switch

When this is done, the pump switches on and the word 'ON' will be displayed, provided the pump control threshold values are OK.

The pump control threshold values are shown on the second line of the LCD. This line starts with 'OFF @' (off at), followed by a level setting in percent (eg, 5%) and a temperature setting in °C (eg, –2°C).

In practice, the pump will not switch on if the temperature is below the threshold value or if the water level is beyond the threshold value. Conversely, if a pump is on, it will switch off if the values received from the level meter are below the temperature threshold or beyond the water level threshold setting.

Water level

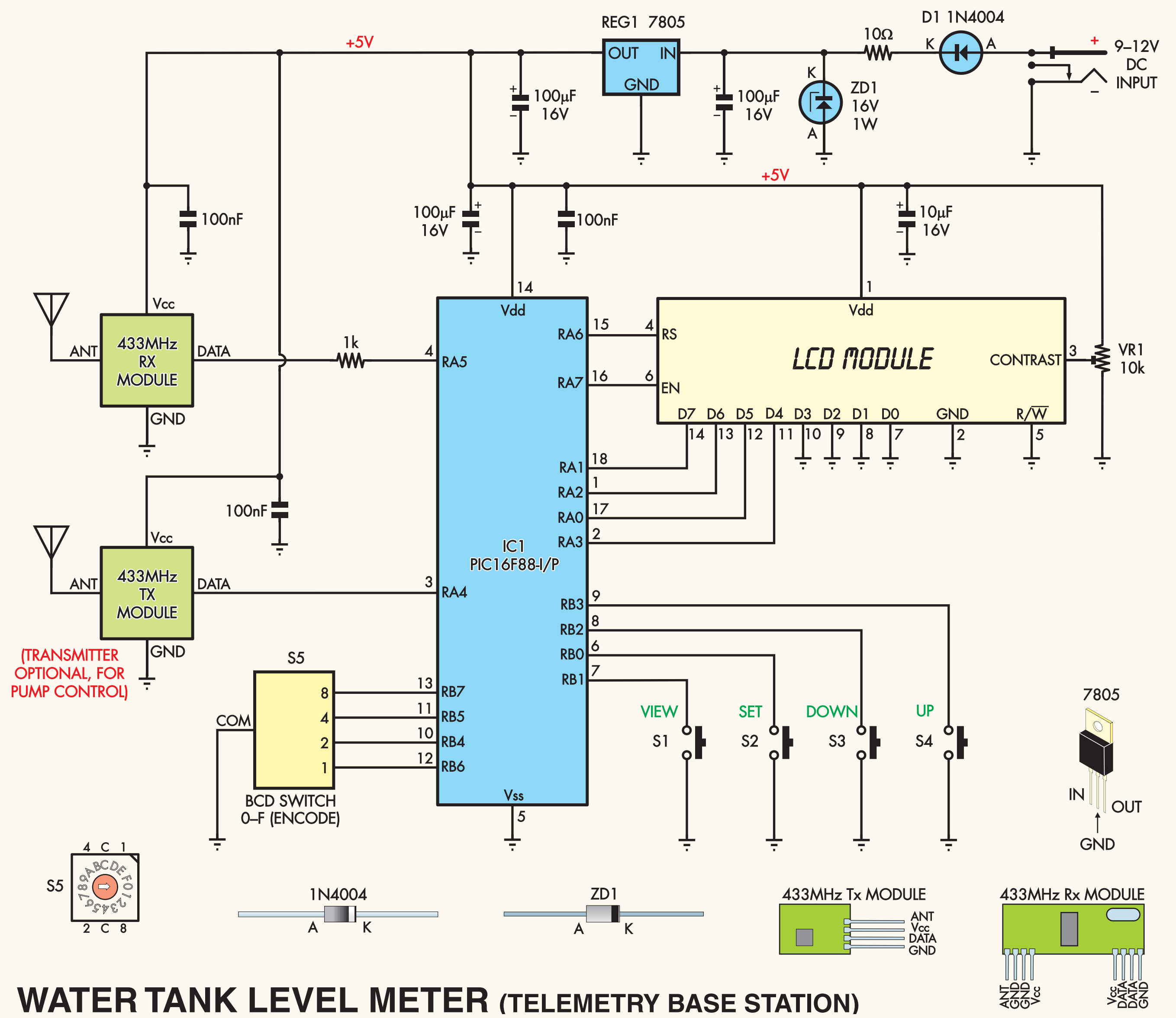
The water level setting threshold works in two ways. First, suppose you are using a pump to extract water from a tank, as is normal if the tank is used to supply water for a house. In this case, the unit would be set to automatically switch off the pump when the tank water drops below the set threshold. This is done to prevent the pump running continuously when the tank water has been depleted.

Basically, the unit will switch off the pump if the level threshold is set to 50% or less. Typically, the threshold would be set well below 50%, at say 15% or 10%.

Conversely, you might want to use a pump to fill a tank from another supply; eg, from a bore or from another tank. In this case, you want the pump to switch off when the water level reaches the preset value so that the tank does not overflow. For the Base Station pump control, a level setting that is over 50% will switch the pump off when the water level reaches the set threshold.

So, the pump automatically switches off for rising or falling levels, depending on whether the setting is above or below the 50% threshold.

Note that the Base Station does not directly control the pump (or pumps). Instead, it transmits a UHF signal to a UHF Remote Control Mains Switch, and this in turn switches the pump on or off. We published a suitable *UHF Remote Control Mains Switch* in our



WATER TANK LEVEL METER (TELEMETRY BASE STATION)

Fig.1: the Base Station uses a 433MHz receiver module to pick up data from the Water Tank Level Meter(s). This data is then fed to PIC micro IC1, which in turn drives the LCD module. The 433MHz transmitter is only necessary for pump control.

Jan '10 issue of *EPE*. You will need to build one of these for each pump you wish to control.

Temperature control

If the outside temperature is at or below 0°C, the water in the pipes that connect to the tank may freeze. If that happens, then having a pump start up could destroy both the pump itself and the connecting hoses.

For this reason, the unit includes temperature control. This automatically switches the pump off if the temperature drops below a preset value.

The actual threshold setting will depend on the climate at your location and how well the pipes are protected from the environment. If your pipes are underground, then they may never freeze up. Conversely, if the pipes are exposed, then they may easily freeze.

Generally, you would set the temperature to around –2° C. That's because the water in the pipes is not likely to freeze until the temperature drops several degrees below zero for a reasonable period of time.

Remote Control Mains Switch

In operation, the UHF Remote Control Mains Switches receive the on or off signals from the Base Station to control the pumps. These switches are each assigned a number from 0-9, corresponding to the tank number and its pump. This ensures that the correct UHF Remote Control Mains Switches respond to signals from the Base Station.

Another important feature of each UHF Remote Control Mains Switch is brownout detection. A brownout occurs when the mains voltage drops well below its normal value, due to a fault condition in the mains supply. This not only affects the brightness of lights, but also and more seriously, can cause pumps and other electric motors to burn out. That's because, at low voltage, electric motors draw excessive

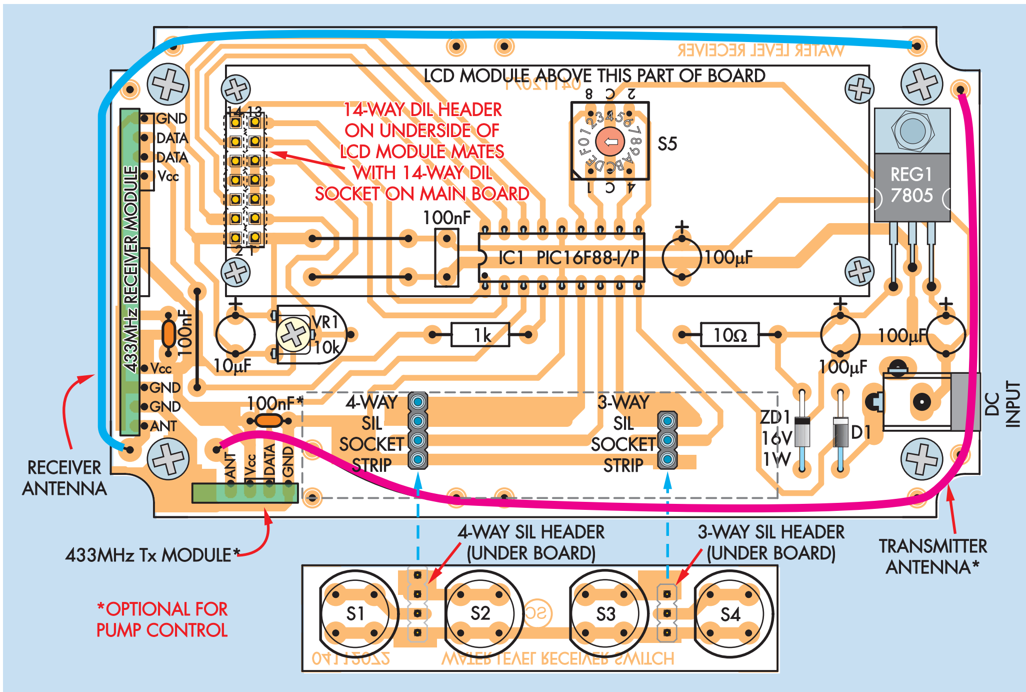
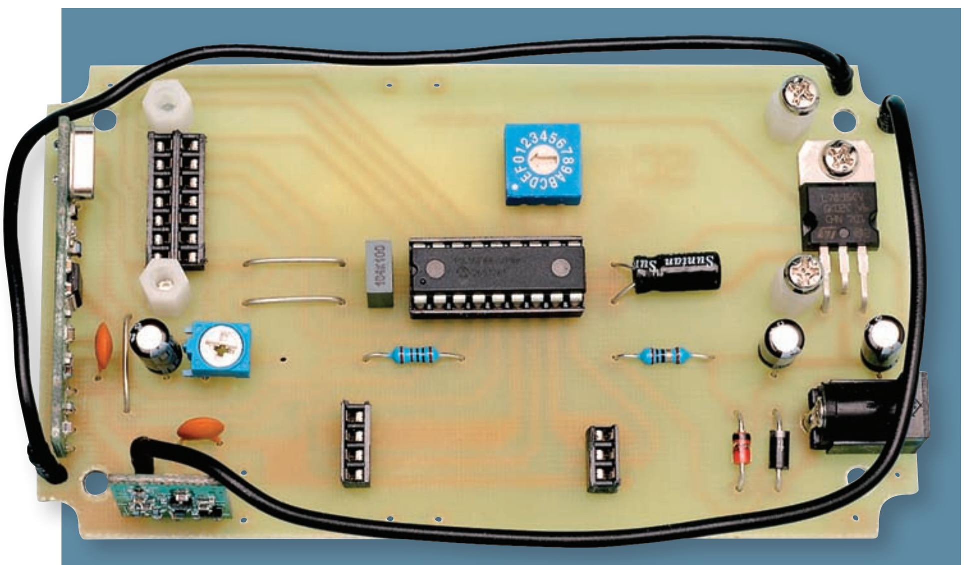


Fig.2: follow this parts layout diagram to build both the main board and the switch board. Take care with the orientations of the 433MHz receiver and transmitter modules – their pin assignments are clearly marked on their PC boards. Note also that switches S1 to S4 must be installed with their flat sides as shown.



This view shows the completed main-board assembly, prior to installation of the LCD and switch modules. Note the the PIC microcontroller is not plugged into its socket until after some initial power supply checks have been completed.

current (and thus overheat) when they do not spin at their normal RPM.

To prevent this, the UHF Remote Control Mains Switch switches off the supply to the pump if a brownout is detected (see *EPE* Jan '10 issue).

Circuit details

The circuit for the Water Tank Level Meter Base Station is really quite simple. As shown in Fig.1, it's based on a PIC16F88 microcontroller (IC1) and a 2-line × 16-character LCD module. Apart from that, there's just a couple of 433MHz receiver and transmitter modules, a BCD switch, four pushbutton switches and a few sundry bits that are mainly in the power supply.

Of course, some of the components are quite complex in themselves, such as the 433MHz receiver and transmitter modules, the LCD module and the microcontroller. However, these can be considered simply as 'building blocks', since we don't need to know too much about their internal operation to make them work as intended.

IC1, the microcontroller, is at the heart of the circuit. It monitors the signal from the 433MHz receiver (Rx) and in turn drives the LCD and the 433MHz transmitter (Tx) that provides pump control. It also monitors pushbutton switches S1 to S4 and the encode switch (S5).

Note that while the 433MHz receiver is vital to receive data from the level meters, the 433MHz transmitter is only necessary for pump control. If you don't intend to use this unit for pump control, then the transmitter can be omitted.

Received data

As shown in Fig.1, the data received by the 433MHz Rx (receiver) module is applied to the RA5 input of IC1 via a 1kΩ current-limiting resistor. This resistor is included because IC1 can latch up if excessive current flows into or out of this pin if the input goes above +5V or below 0V.

In operation, IC1 reads the data signal by clocking it in at a rate set by the transmission locking pulse. This data is then accepted by IC1 if the format is correct and the encode value matches the setting of BCD switch S5 (ie, the encode switches in the level meters and the Base Station must match each other).

If the encode settings do not match, then the data signal will be rejected.

BCD switch S5 is connected to the RB4 to RB7 inputs of IC1, and can pull these inputs to ground when its '2', '4', '1' and '8' switches are closed respectively. Basically, it is a rotary switch with 16 settings ranging from 0-9 and A-F. For the 0 setting, all switches are open and for the F setting all switches are closed. Settings in between 0 and F have different combinations of open and closed switches.

For example, '1' will tie IC1's RB6 input to ground. However, each RB4 to RB7 input will be pulled to the +5V supply rail when its corresponding switch is open. That's because each of these inputs has an internal pull-up resistor of about 20kΩ.

In operation, each switch setting can be checked by IC1 because a low voltage on the input means that the switch is closed, while a high voltage means that the switch is open.

Switches S1 to S4 (View, Set, Down and Up) on the RB0-RB3 inputs are monitored in a similar way.

Ports RA0 to RA3 and RA6-RA7 are used to drive the LCD module. As shown, RA0 to RA3 drive the D4 to D7 data lines, while RA6 and RA7 drive the register select (RS) and enable (EN) lines respectively. Trimpot VR1 sets the display contrast voltage.

Driving the transmitter

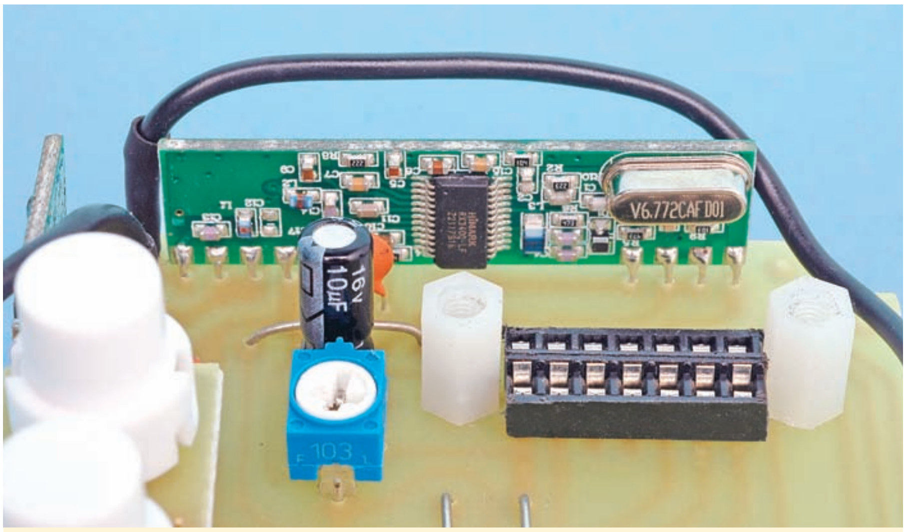
The pump control signal appears at IC1's RA4 (pin 3) output and is fed to the 433MHz transmitter. In practice, the Base Station can individually control up to 10 UHF Remote Control Main Switches, which in turn switch the pumps on and off as required.

The data transmission protocol is as follows: initially, a 50ms transmission is sent to set up the receiver so that it is ready to accept data. That done, a 16ms locking signal is sent, followed by a 4-bit encode number and a 4-bit tank number.

An 8-bit pump-on or pump-off signal is then sent. This is either 162 for pump-on or 150 for pump-off. Finally, an 8-bit stop code with a value of 204 is sent. These stop bits indicate that the signal is for pump control and differ from those used for the transmissions from the Water Tank Level Meters.

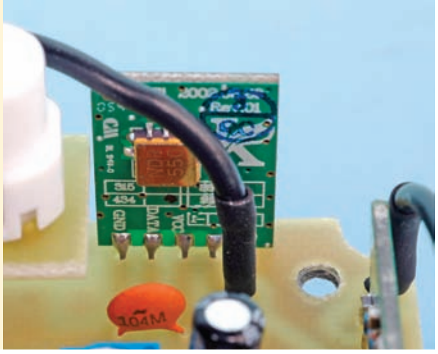
Power supply

Power for the circuit comes from an external 9V to 12V DC plugpack



Installing The 433MHz Receiver and Transmitter Modules

These larger-than-life-size photos clearly show how the receiver (top) and transmitter (right) modules are installed on the main PC board. You can leave the transmitter module out if you don't intend to use the pump control feature.



supply. Diode D1 provides reverse polarity protection, while Zener diode ZD1 clamps any voltage spikes to 16V. A 10Ω resistor in series with the supply rail provides current limiting.

A 100μF capacitor decouples the supply rail, which is then fed to 3-terminal voltage regulator REG1. This produces a regulated +5V supply rail, with further supply bypassing provided by another 100μF capacitor directly across REG1's output.

Additional 100μF, 10μF and 100nF bypass capacitors are also used to decouple the supply to microcontroller IC1, the LCD module and the 433MHz transmitter and receiver modules.

Software

The software files are available via the *EPE* Library site, accessed via **www.epemag.com**. Pre-programmed PICs will also be available from Magenta Electronics – see their advert in this issue for details.

Construction

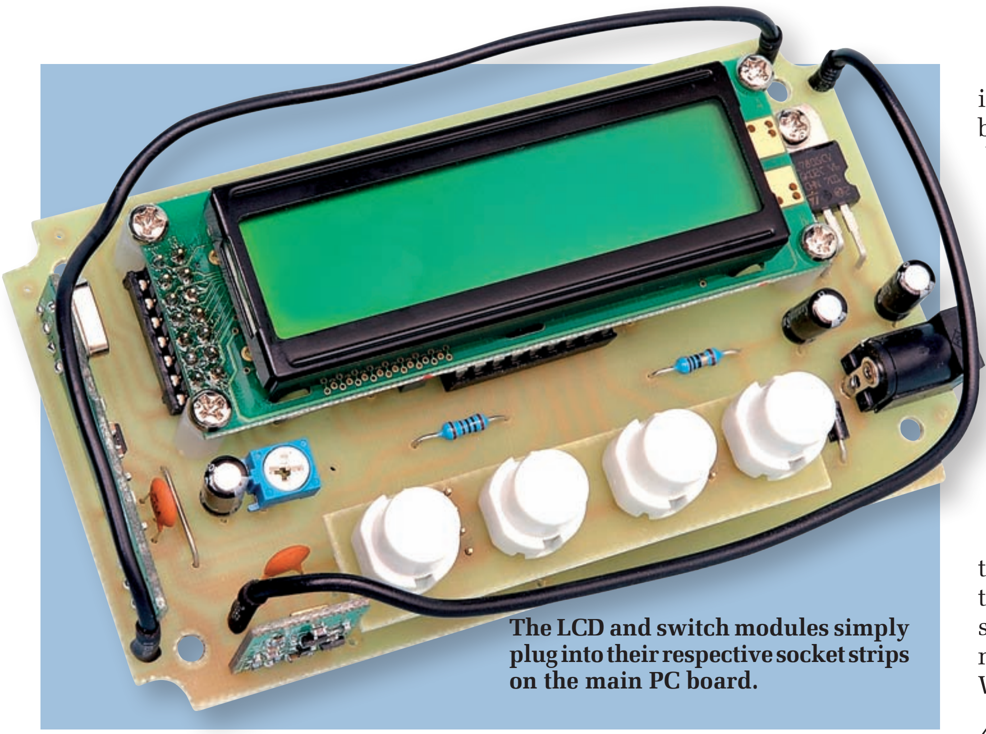
The Water Tank Level Meter Base Station is built using two PC boards – a main board, code 757 Base, (115 × 65mm) and a switch board, code 758 Switch, (63 × 15mm). The latter carries just four pushbutton switches (S1-S4) and two 4-way SIL header strips. These boards are available as a set from the *EPE PCB Service*.

The boards are housed in a bulkhead-style case fitted with a clear lid, measuring just 120 × 70 × 30mm. Note that if you intend including pump control, then the 433MHz transmitter and its associated components must be installed.

Begin construction by checking the PC boards for any defects, such as shorted tracks or breaks in the copper areas. That done, check that the hole sizes are correct. In particular, the holes for the four corner mounting screws, the four LCD mounting points and for REG1 should be 3mm in diameter.

Check also that the main PC board fits into the box. It should have a circular cut-out at each corner so that it clears the corner pillars. If necessary, cut these out and file the edges of the board until it is a neat fit.

That done, you can now begin installing the parts. Fig.2 shows the



The LCD and switch modules simply plug into their respective socket strips on the main PC board.

component layout diagram. Install the two resistors first, taking care to use the correct value at each location. It's just a matter of using a digital multimeter to check their values, before soldering them in position.

The three wire links can go in next, followed by PC stakes for the receiver antenna connections. You should also install additional PC stakes for the transmitter antenna connections if pump control is to be used.

Follow these with diode D1 and Zener diode ZD1, taking care with their orientation. That done, install a socket for IC1, making sure that the notched end goes to the left; ie, towards the 100nF capacitor. Don't install IC1 yet, though – that step comes later, after some initial power supply checks.

Next on the list are the 4-way and 3-way SIL (single in-line) sockets (used later to mount the switch PC board). These two sockets can be made by using a sharp knife to cut down an 8-pin DIL (dual in-line) IC socket. Clean up the edges with a small file before mounting the sockets.

Similarly, you also need to install two 7-way SIL socket strips to accept the connections for the LCD module. These can be made by cutting and filing a 14-pin DIL IC socket.

Now for the capacitors. Note that three of these are electrolytic types and must be oriented with their polarity as shown. In addition, the 100µF capacitor to the right of IC1 must lie horizontally on the PC board; ie, it's installed with its leads bent down by 90° (see photo).

Note also that there are three 100nF capacitors on the board. The two ceramic types go in adjacent to the 433MHz receiver and transmitter modules, while the 100nF MKT capacitor is positioned immediately to the left of IC1.

This view shows how the 3-way and 4-way pin headers are installed on the switch board – see text.

Regulator REG1 is installed so that its metal tab sits flat against the PC board. The procedure here is to first bend the regulator's centre lead down through 90° some 5mm from its body, after which its two outer leads can be bent down about 7mm from the body. That done, the device is fitted to the board and fastened using an M3 × 6mm screw and nut before soldering its leads.

Don't solder the leads before bolting the device to the PC board. If you do, you could stress and fracture the PC tracks as the device is tightened down.

The DC socket, BCD switch S5 and trimpot VR1 can now go in. Be sure to orient the BCD switch exactly as shown in Fig.2, and set it to the same number as the encode switches in the Water Tank Level Meters.

433MHz modules

The main board assembly can now be completed by installing the 433MHz receiver and transmitter modules. As previously stated, the latter is only necessary if pump control is required, otherwise simply leave it out. Make sure that these parts are correctly oriented (see photos) – their pins are clearly marked.

You will also need to install the antennas for these modules. These antennas are made using 170mm lengths of hook-up wire, each running from its module's antenna PC stake to a PC stake at the opposite corner of the board.

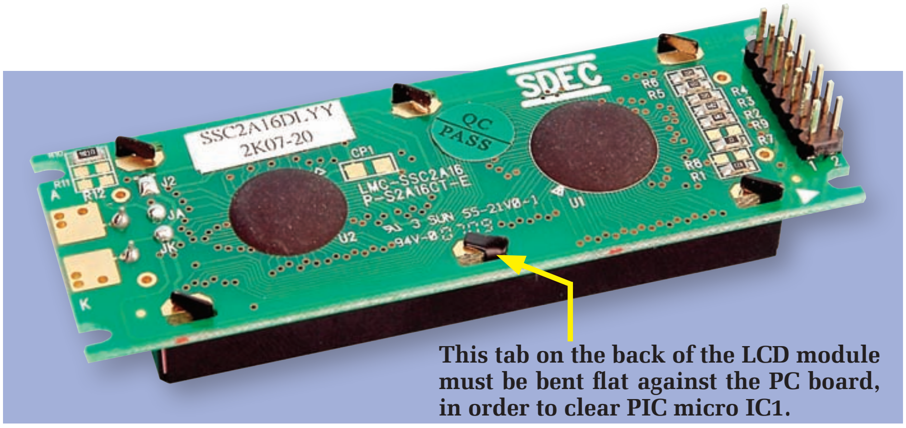
Switch board

The switch board should only take a few minutes to assemble. Begin by installing the four pushbutton switches, making sure that each switch has its flat side oriented as shown. That done, the 3-way and 4-way headers can be installed.

These headers are installed on the track side of the PC board (see photo). Install each one so that its pins protrude about 1mm above the board surface, then solder the pins and slide the plastic spacer towards the PC board until it rests against the solder joints. The assembled switch board can then be plugged into the main board.

Mounting the LCD module

The LCD module is connected in similar fashion to the switch board.



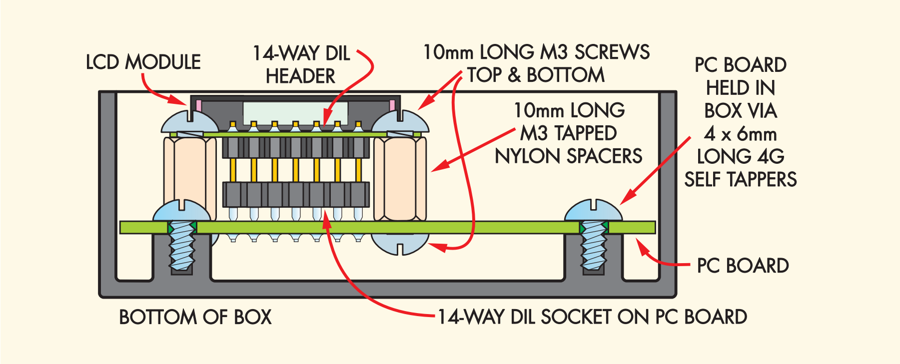


Fig.3: the LCD module plugs into the 14-way DIL header and is supported on four M3 × 10mm tapped nylon spacers.

In this case, you have to carefully solder a 14-pin DIL header to the module, and once again, this has to be installed from the underside of the PC board.

Push the header in so that its pin length below the PC board is exactly 8mm (an 8mm-wide cardboard strip makes a handy alignment tool). That done, carefully tack solder a couple of pins, make any adjustments as necessary, then complete the soldering.

Note that you will need a soldering iron with a very fine tip for this job, to avoid butchering the fine tracks on the top of the LCD module.

Applying power

Now for the smoke test. This is done with IC1 out of its socket and the LCD module unplugged.

First, apply power and check that there is 5V between pins 14 and 5 of IC1's socket. If this is correct, switch off and install IC1 with its notched end towards the 100nF capacitor (see Fig.2).

Next, install four M3 x 10mm tapped nylon spacers on the main board to mount the LCD module. Secure these using M3 × 6mm screws, then plug the LCD module in and secure it to the spacers using another four M3 × 6mm screws.

Note that there is a tab beneath the LCD module which interferes with IC1 when you attempt to mount the module in place. This tab must be bent over to lie flat against the LCD module's PC board to avoid this problem.

The completed assembly can now be installed in its case. If you are building from a kit, the case will probably be supplied with a screen-printed label and with all the necessary holes drilled. If not, then you will have to drill the holes yourself.

You will need four 10mm holes in the lid of the case to clear the switch caps, plus a 6mm hole in the side of the case to give access to the DC socket. The latter is located 9mm down from the top of the base and 12mm in from the side.

The switch holes in the lid can be drilled using a photocopy of the front panel label shown in Fig.4 as a template. These can initially be drilled out to about 5mm using a small pilot hole to start with, and then carefully reamed out to 10mm.

That done, a colour copy (Fig.4) of the front-panel artwork can be attached to the lid using double-sided adhesive tape. It can then be protected by using a single layer of clear self-adhesive film (eg, wide sticky tape) and the holes cut out with a sharp utility knife.

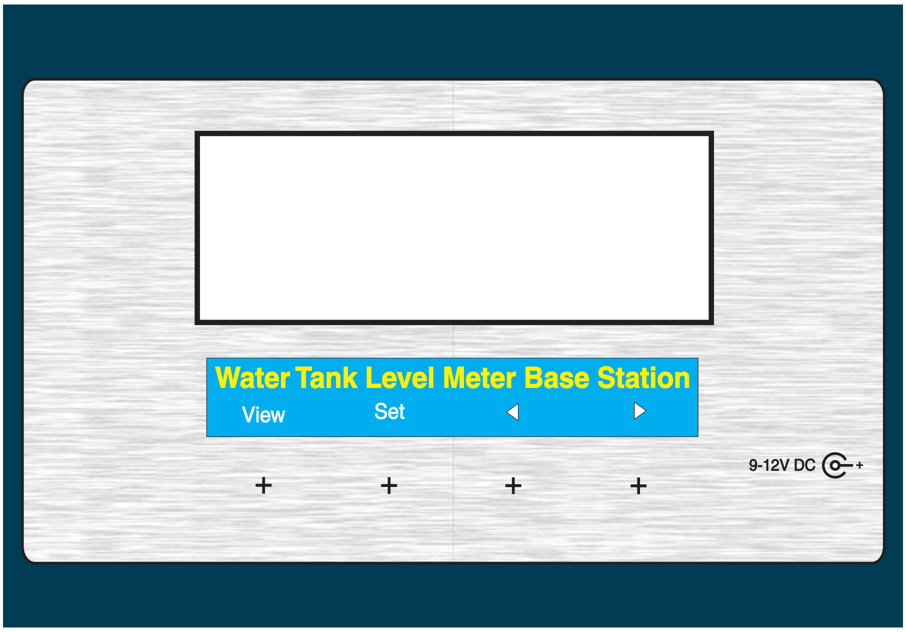
Parts List – Telemetry Base Station

1 PC board, code 757 Base, size 115mm × 65mm
1 PC board, code 758 Switch, size 63mm × 15mm
Both boards are available as a set from the *EPE PCB Service*
1 bulkhead case with clear top, 120 × 70 × 30mm (Jaycar HB-6082 or equivalent)
1 9VDC 200mA plugpack
1 LCD module with backlight (Jaycar QP-5516 or equivalent)
1 PC-mount 2.5mm DC socket
1 433MHz receiver module (Jaycar ZW-3102 or equivalent)
1 433MHz transmitter module (Jaycar ZW-3100 or equivalent) (optional for pump control)
4 click-action PC-mount switches (S1-S4)
1 0-F 16-position BCD switch (S5)
1 14-pin DIL header (2.54mm pin spacing)
1 4-way SIL header (2.54mm pin spacing)
1 3-way SIL header (2.54mm pin spacing)
1 14-pin DIL IC socket (cut to suit the 14-pin DIL header)
1 8-pin DIL IC socket (cut to make 4-way and 3-way SIL sockets)
1 18-pin DIL IC socket
4 M3 × 9mm or M3 × 10mm tapped Nylon spacers
9 M3 × 6mm screws
1 M3 nut
4 No.4 × 6mm self-tapping screws
1 80mm length of 0.7mm tinned copper wire
1 170mm length of medium-duty hookup wire
1 170mm length of medium-duty hookup wire (optional for pump control)
2 PC stakes
2 PC stakes (optional for pump control)
1 10kΩ horizontal trimpot (code 103) (VR1)

Semiconductors
1 PIC16F88-I/P pre-programmed microcontroller (IC1)
1 7805 5V regulator (REG1)
1 1N4004 1A diode (D1)
1 16V 1W Zener diode (ZD1)

Capacitors
3 100µF 16V PC electrolytic
1 10µF 16V PC electrolytic
1 100nF MKT polyester
1 100nF ceramic
1 100nF ceramic (optional for pump control)

Resistors (0.25W 1% metal film)
1 1kΩ
1 10Ω



Alternatively, you can trim the label to fit inside the lid by making cutouts for the four corner pillars. It can then be attached using a smear of clear silicone sealant.

The board assembly simply sits on integral standoffs on the bottom of the case, and it is secured using No.4 self-tapping screws. That done, apply power, and adjust trimpot VR1 for optimum contrast on the LCD.

The assembly can now be completed by attaching the lid and mounting brackets using the four screws supplied with the case.

Setting up

At this stage, when power is applied, the display should show a question mark (ie, '?') for tank 1's level. You now need to enable the tanks that are to be monitored using the procedure described earlier. Once that's done, the correct level will be displayed for each tank.

The Base Station needs to be positioned so that it can receive signals from all the Water Tank Level Meters that are to be monitored. In each case, when a valid signal is received, the display will show the signal level for that tank instead of a question mark.

During our trials, we found that there were places inside the house where the reception was unreliable, particularly when the Water Tank Level Meter was more than 100m away. In practice, it's a matter of finding the best place to receive signals from all the level meters.

In addition, it may be necessary to position each level meter so that it is on the side of the tank that faces the Base Station. The antenna can also play a role here, and an antenna consisting of a length of 1mm wire that extends straight out of the Water Tank Level Meter (ie, from the transmitter) can improve reception at the Base Station. Some experimentation with the antenna orientation may also be necessary.

Fig.4: this full-size front-panel artwork can be photocopied and used as a drilling template for the case lid. A second copy can be printed out and attached to the lid using double-sided adhesive tape – see text.

Addendum: improving the pressure sensor

As detailed in the last two articles, the Water Tank Level Meter uses a pressure sensor to measure the water level. Here's a few tips on improving the set-up, plus an improved method for mounting the pressure sensor externally.

AS originally described in April 2010, the *Water Tank Level Meter* used a pressure sensor that was mounted inside the case (ie, on the PC board). This sensor was connected to a tube that was then inserted into the tank, with one end close to the bottom.

The resultant air pressure within the tube thus provided a measurement of water level.

An alternative method was subsequently described in the May issue, and this involved mounting the pressure sensor in a sealed box at the bottom of the water tank. The electrical output from the sensor was then fed back via a cable to the Level Meter.

Since publication of these articles it has come to our attention that the 'tube in tank' method is only valid for short-term water level measurements. Unfortunately, the measurements will become inaccurate after an extended period of time. This is due to some diffusion of the air into the water, resulting in a loss of pressure.

As a result, our first measurement technique (ie, where the sensor is mounted on the PC board) is no longer recommended for long term monitoring. By contrast, the in-tank sensor measurement technique described in the May article is suitable, because this is not affected by pressure loss due to the diffusion of air into the water.

Making it better

Assuming that you do decide to mount the pressure sensor inside the tank (see pages 30 and 31, May 2010), there are a number of things that you should do to improve the sensor's long-term reliability.

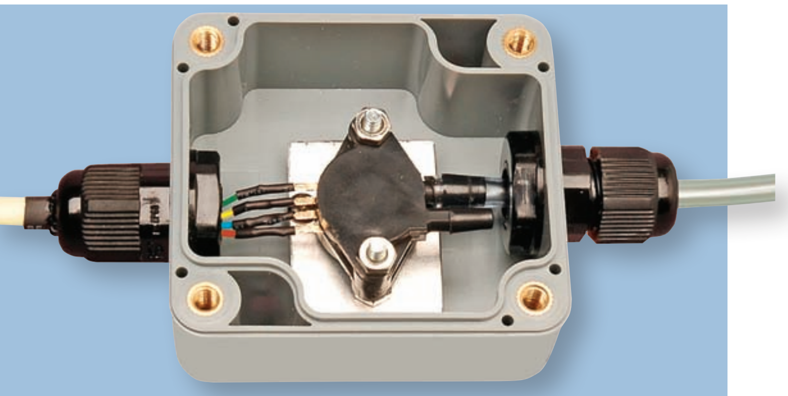
First, a short squirt of silicone water repellent should be directed into both sensor ports, to improve water protection at the sensor's gauge. In addition, a few drops of mineral oil should be placed in the tube, so that an air pocket and oil trap is formed just above where the tubing is clamped to the box. This is to prevent direct contact between the sensor and the water at port 1.

Note that there should be a small amount of air left between port 1 and the oil. The oil repellent action of the silicone spray is also helpful here. Note that mineral oil is available from pharmacies as baby oil.

Water in the vent tube

One problem is that the vent tube for port 2 may ultimately contain water in the lower portion of the U-shaped section in the sealed box at the bottom of the water tank. This is due to water condensation from the air, and if enough water condenses to close off the tube, this will lead to inaccuracies in the pressure reading due to incorrect pressure at port 2 with barometric changes.

As a result, if the water level readings appear to be inaccurate, the



This external sensor assembly is designed to connect directly to the outlet at the base of the water tank via a T-piece. Refer to Fig.1 for the assembly details.

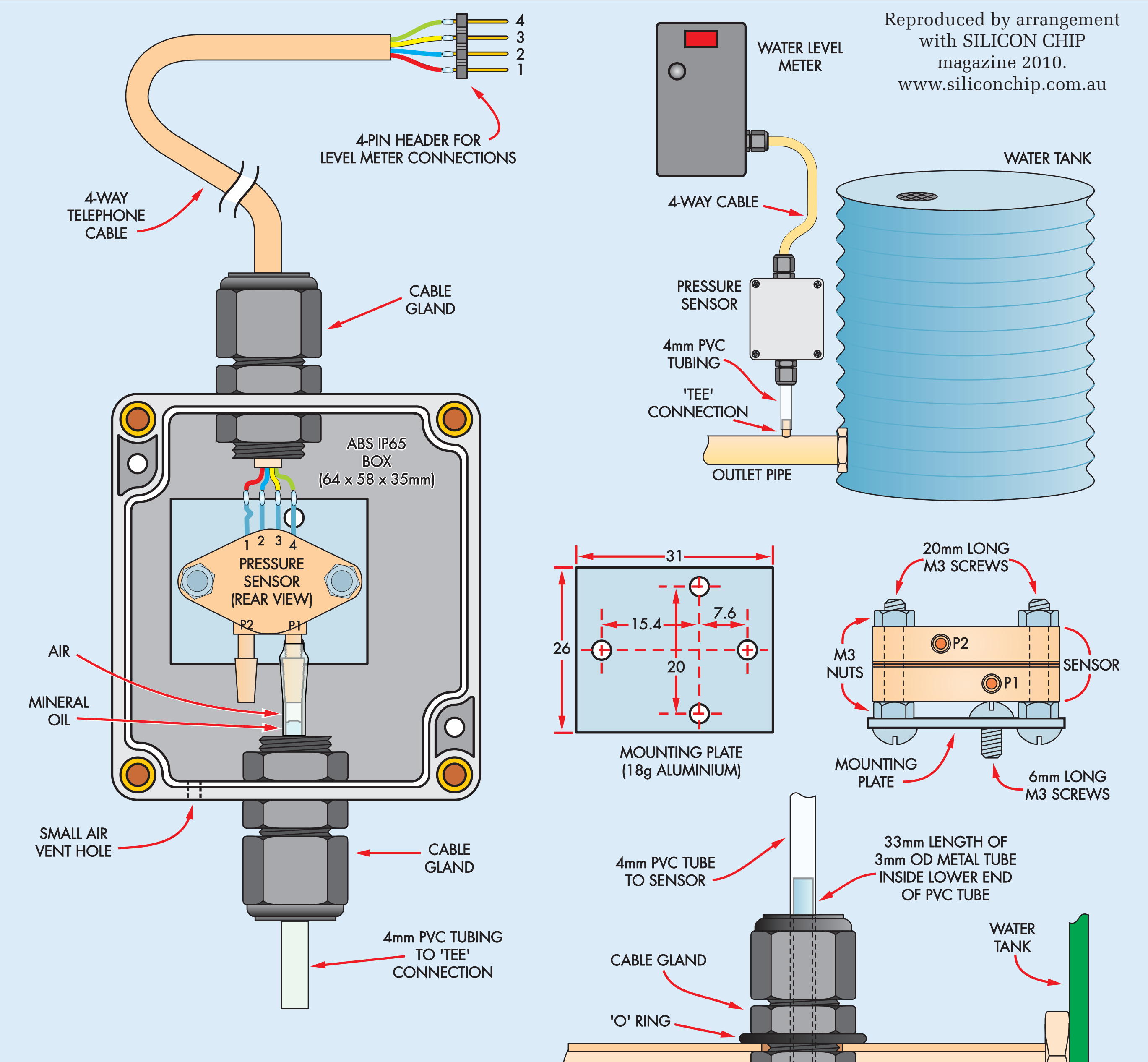


Fig.1: follow these diagrams to build and install the external pressure sensor. As shown, the sensor is mounted in a waterproof box and connects to the tank's outlet via a T-piece made up using a metal tube and a cable gland. Don't forget to drill a small hole in the underside of the box, so that atmospheric pressure is applied to port 2 (P2) of the sensor (see text).

condensation will have to be drained from the tube. To do this, simply remove the sensor assembly from the tank and tip out the water.

Having said that, this degree of condensation is unlikely to occur except in very humid climates. If necessary, the effect can be minimised by placing a water-absorbing desiccant (eg, silica gel) within the tube.

Alternative sensor placement

Another recommended technique for water level measurement has the sensor located outside the water tank. This arrangement is shown in Fig.1 and involves connecting the pressure sensor input directly to the outlet connection at the base of the water tank.

The main advantage of this scheme is that because the sensor and its wiring are now located outside the tank, there is no need to fully seal the inside of the box.

Parts List

1 IP65 sealed enclosure 64 × 58 × 35mm (Jaycar HB-6120 or equivalent)
1 31 × 26mm sheet of 18g aluminium
2 3mm to 6mm waterproof cable glands
3 M3 × 6mm screws
2 M3 × 20mm screws
4 M3 nuts
1 4-way pin header
1 50mm length of 4mm PVC tubing
1 4-way sheathed cable (length to suit application)
1 set of fittings suitable for water tank 4mm tubing connection

The connection to the tank's outlet can be made using a 'Tee' connector. This can be obtained from an irrigation supplier (eg, a T-piece as used for drip irrigation) or you can fashion your own fitting. An alternative is to use a small metal tube inserted into a metal tap fitting, which would then accept the PVC tubing from the sensor. This metal tube can be brazed, soldered or glued in place.

If you are using 25mm or larger poly pipe at the tank outlet, then a T-piece can be made by first drilling a hole in the side of the pipe close to its end, to accept a 3 mm to 6mm cable gland. This hole needs to be positioned close to the end so that access is available to flatten down the tube at the mounting area and to provide access to the gland nut inside the tube.

The seal between the gland and poly pipe can be improved by using an 'O' ring (as shown in Fig.1) or by using a silicone sealant that's suited for wet areas (or you can use both). A 3mm OD metal (or hard plastic) tube then needs to be placed inside the PVC tube so that the gland will not close off the PVC tube when it is tightened down. Metal tubing this size can be salvaged from a telescopic antenna.

Sensor mounting

As shown, the sensor is mounted on a small aluminium plate within a sealed enclosure. This baseplate is made up using sheet aluminium measuring 31 × 26mm and is attached to the two central internal mountings posts using M3 × 6mm screws. The sensor itself is attached to the baseplate using two M3 × 20mm screws and M3 nuts.

As shown in Fig.1, the port 1 connection comprises a 3mm PVC tube that connects to the T-piece in the water tank's outlet. Port 2 vents to the atmosphere.

A 4-way cable (eg, telephone cable) is connected to the four sensor pins and exits from the top or side of the box through a cable gland. Note that you must orient the sensor so that port 1 is connected to the tubing. **As shown, the sensor is mounted with pin 1 (the notched pin) to the left.** Make a note of the wire colour used for each connection to the sensor.

At the other end, this wiring connects to the socket in the Water Tank Level Meter via a 4-way pin header connection. Make sure that this connection is made with the correct orientation and don't get the wiring mixed up.

Making it water-tight

Note that if you are using a flat 4-way cable, it will not form a watertight seal within the gland. This can be fixed by applying a small amount of silicone sealant around the wire at the entry and exit points of the gland, so that the box is waterproof.

In addition, a small hole must be drilled in the box to allow the air pressure to vary inside the box for the sensor's P2 port. This hole should be drilled so that it is in a bottom panel when the box is mounted in position, to keep water out. A hole size of just 1.5mm is all that's required.

The same recommendations we made above for the in-tank sensor installation also apply here. These are to improve reliability from the sensor – ie, use a squirt of silicone water repellent into both sensor ports and place a few drops of mineral oil in the tube so that air and oil can then be trapped just above where the tubing is clamped in the gland.

As before, the oil is to prevent direct contact between the port 1 sensor and the tank water. Don't overtighten the cable gland for the port 1 tube – you don't want to close off the tube completely.

Mounting it in place

The box can be mounted on the side of the tank, so that the port 1 tube sits vertically. This keeps the mineral oil floating on top of the water.

Note that it's important to keep the port 1 sensor input as low as possible, so that it sits just above the tank's outlet. That way, the full range of the tank can be measured. Also, try to prime the tubing with water up to the gland before attaching it to the tank T-piece, so that the initial calibration will be correct. If there is too much air, you may need to recalibrate after the air has diffused into the water.

Note that the box has two mounting points that are effectively outside the box's sealed section, but are still covered by the lid. So, to access the mounting holes, you have to remove the lid.

The unit can be mounted on brackets or directly onto a wall or the tank. To mount it to the side of the tank, first mount two lengths of 19 x 19 x 70mm hardwood, spaced apart to match the box's mounting holes. This timber can be secured to the tank using builder's adhesive or silicone sealant. The box is then attached using suitable wood screws into the timber (but not so long that they can penetrate the wall of the tank).

Just as with the in-tank sensor, note that temperature compensation is not required and the unit should be left at the zero compensation setting.

The Water Tank Level Meter can be mounted in any convenient location, even if it is exposed to sunlight (since the temperature sensor no longer has to correct for the air temperature in the tube). *EPE*

Part 2: By MAURO GRASSI

DSP Musicolour: putting it together

In last month's article, we described the circuit operation of the DSP Musicolour. In this instalment, we guide you through the construction. The operation of the firmware and troubleshooting tips will be described next month.

Before we start any construction, let's make a couple of things perfectly clear about the complexity and skill levels needed to build the *DSP Musicolour*.

1) This project is **not** suitable for beginners. In fact, you should not attempt to construct this project without considerable experience, particularly with mains devices.
2) This project controls mains (230V/240V or 110V/120V) voltages. Mains voltage can be lethal. **Hence, it is especially important to double check and be certain that mains power is not applied whenever working with the PC boards. NEVER apply mains power to the main PC board unless it is fully enclosed in a plastic case with the case screws done up.**

The DSP Musicolour is built on two separate PC boards. These boards are available as a set from the *EPE PCB Service*. The main board (Fig.3) consists of the triac output section at 230V/240V AC mains potential and the low voltage section containing the op amps and the dsPIC30F4011 microcontroller. The two sections of the main board are isolated by optocouplers and the mains transformer. The vertical display board (Fig.1) is all low voltage circuitry; its supply rail is +5V.

Software

The software files are available via the *EPE Library* site, accessed via **www.epemag.com**. Pre-programmed PICs will also be available from Magenta Electronics – see their advert in this issue for contact details.

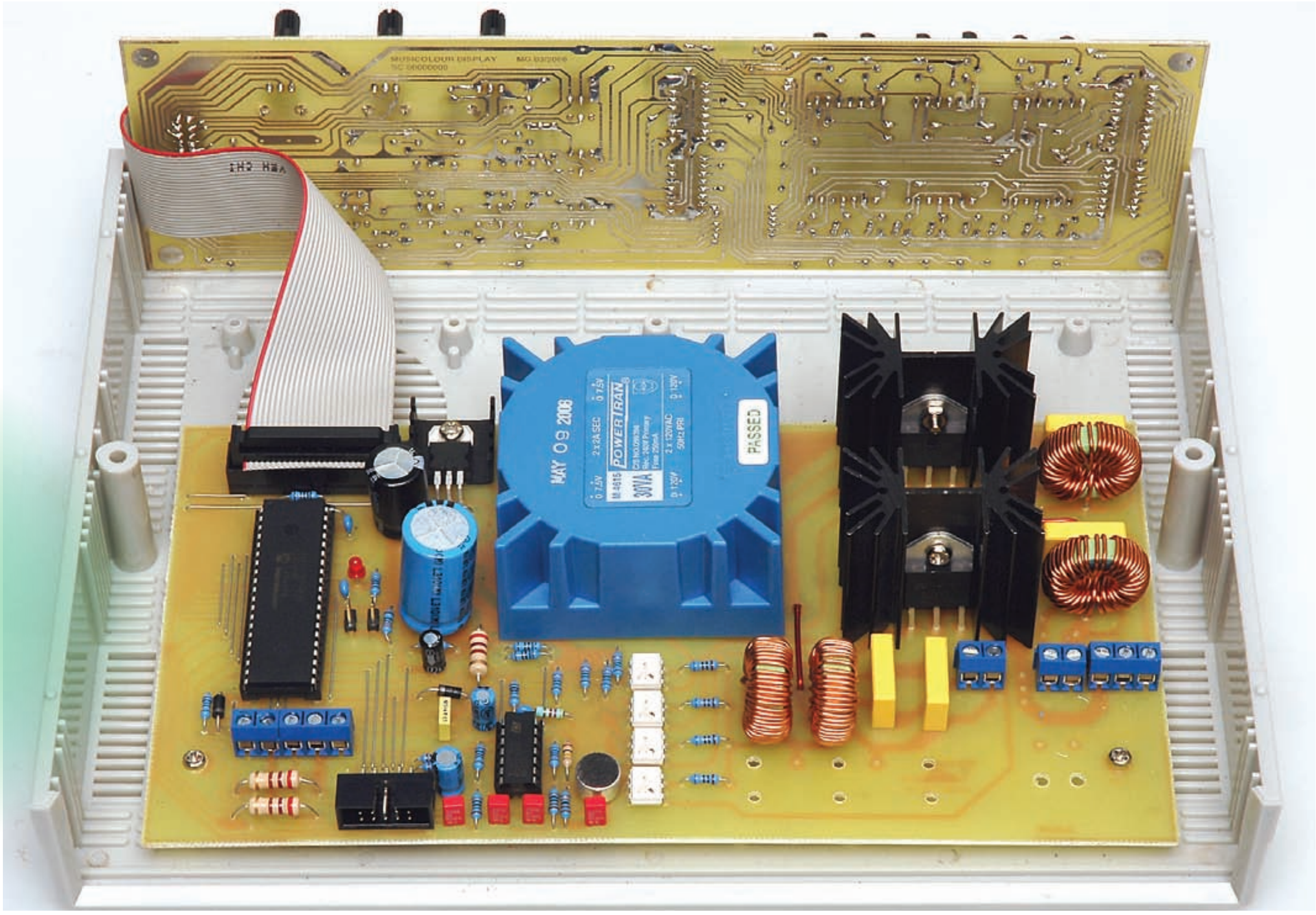
Construction: Display board

We'll begin the construction with the display board, which is coded 760 and measures 247mm × 76mm. Note: our prototype DSP Musicolour used single-sided boards with many links; however, kit suppliers are likely to provide the boards in double-sided form with plated-through holes, in which case only a few links will be necessary.

First, you should check the PC board for hairline cracks in the tracks and any visible shorts between tracks. Fix any defects.

The component overlay is shown in Fig.1. The first components to go in are the resistors, 31 in total. As you install them, check the value of each resistor, ideally with a digital multimeter before soldering each one onto the PC board.

The seven signal diodes can be soldered in next. It is vital that they are oriented correctly and you should refer to the component overlay and check carefully against it. The diode's cathode (K) is indicated by a line at one end of the body.



The main and display boards assembled in the case, before the rear panel (and rear panel wiring) is fitted. This prototype photo has single-sided PC boards – production boards should be double-sided to eliminate most links. However, if you etch your own PC board it will probably be as per the prototype and require links as shown above.

Next, solder in the four 16-pin IC sockets. Make sure these are oriented correctly, as per the component overlay. Although the sockets are optional, we do recommend them. They make replacing the ICs much easier, if needed.

The sockets for the three Kingbright dot matrix LED modules can now be installed. Cut three 14-pin IC sockets in half with pliers to get six 7-pin sockets, and solder them in as shown on the component overlay.

The sockets are used to raise the dot matrix modules to make them sit close to the acrylic front panel. They also make replacing the modules much easier if they should ever fail.

Once this is done, you can solder in the 22 BC327 transistors. These are all *PNP* types, and should be pushed down so that they sit quite close to the board in order to clear the front panel. However, be careful not to push them too close, as this may damage the leads. About 2mm proud of the board surface is ideal.

Next, you can solder in the three 10kΩ potentiometers and the capacitors. The three 100nF monolithic types are placed near the IC sockets for the 74HC595 shift registers (IC3, IC4 and IC5). The two electrolytics are placed near VR3 and must be installed the right way around. Their negative terminals are indicated on their bodies, and you should refer to the component overlay before you solder them to ensure they are correctly in place.

The 26-pin IDC (insulation displacement connector) header (CON7) can be soldered in next, and you should refer to the component overlay to get the correct orientation. Note that

Warning!

All the parts in the red shaded area on the Main Board component layout diagram (Fig.3) operate at mains potential (ie, 230V AC) and contact with any of these parts could be FATAL.

These parts include the PC tracks, the opto-couplers (OPTO1-4), the triacs, the 100µH inductors, the 680Ω resistors, the 100nF 250V AC capacitors, screw terminal blocks CON4-CON6, the transformer primary and the wiring to the mains input and output sockets. DO NOT TOUCH any of these parts unless the power cord is unplugged from the mains supply. DO NOT CONNECT this device to the mains unless it is fully enclosed in the specified case.

This project is not for the inexperienced. Do not build it unless you know exactly what you are doing and are completely familiar with mains wiring practices and construction techniques.

there is a key-way on one side of the socket. Pin 1 of the header should be indicated by an arrow in the plastic socket.

Finally, solder in the seven vertical tactile switches which have LEDs inside. There are three red and four blue switches. These switches have six leads arranged in two rows of three. The middle leads in each of the two rows are used to connect the internal LED, and you should make sure that they are oriented correctly, otherwise the LED will not light up.

For each switch, the cathode (K) is indicated by a dab of coloured paint on the lead with the colour matching the colour of the LED inside the switch. The switch should be soldered with the cathode facing up in the normal orientation. Switches S1 to S3 should be red, and switches S4 to S7 should be blue. **Note that this differs from the prototype photos shown here and in last month's article**.

Ribbon cable assembly

This completes the construction of the display board. The last thing to do is to make up the ribbon (IDC) cable used to connect the display board to the main board. To do this, you will need a vice. Cut 15cm of 26-way ribbon cable and slide it into position into each 26-pin IDC line socket. Conductor 1 of the ribbon cable is indicated by a different colour – usually the ribbon cable is grey and conductor 1 is red. This should match pin 1 of the line sockets, indicated by arrows. You should slide the ribbon cable into place and then use a vice to attach the cable.

Finally, attach the clip to only one line socket leaving the other one without one. The line socket for the display must not have a clip attached, in order to clear the front panel.

Once you are satisfied that everything is in order, you can insert the ICs into their sockets, making sure that they are correctly aligned. Then insert the three Kingbright dot matrix LED modules into their sockets. Make sure that pin 1 of each of the Kingbright modules is facing down, as indicated on the component overlay. The modules should show a digit '1' indicating pin 1.

Attaching the front panel

The final task is to attach the acrylic front panel. The four mounting holes are used to attach the front panel to the display board using four M3 nylon screws (25mm).

You will need to cut off 2mm from four 15mm tapped nylon spacers to make them measure 13mm. This is the correct spacing between the display board and the front panel that fits with the grooves in the specified plastic case.

Finally, cut the remaining four 15mm tapped nylon spacers to 4mm, and use these as the nuts to attach the front panel. Then simply attach the three knobs to the potentiometers and that should complete the assembly of the display board.

Assembling the main board

The main board is coded 759 and measures 221mm × 165mm. The component overlay is shown in Fig.3.

Again, begin the construction by checking the copper pattern for defects such as track breaks or shorts. Fix any defects that may be apparent.

Links for 230V/240V AC or 110V/120V AC operation

Links LK1, LK2 and LK3 need to be installed, depending on whether you will be powering the DSP Musicolour from 110V-120V AC or 230V-240V AC. If you are in the UK, Australia, New Zealand and most parts of contintental Europe, then you will be using 230V-240V, while 110V-120V AC is used in America and Japan.

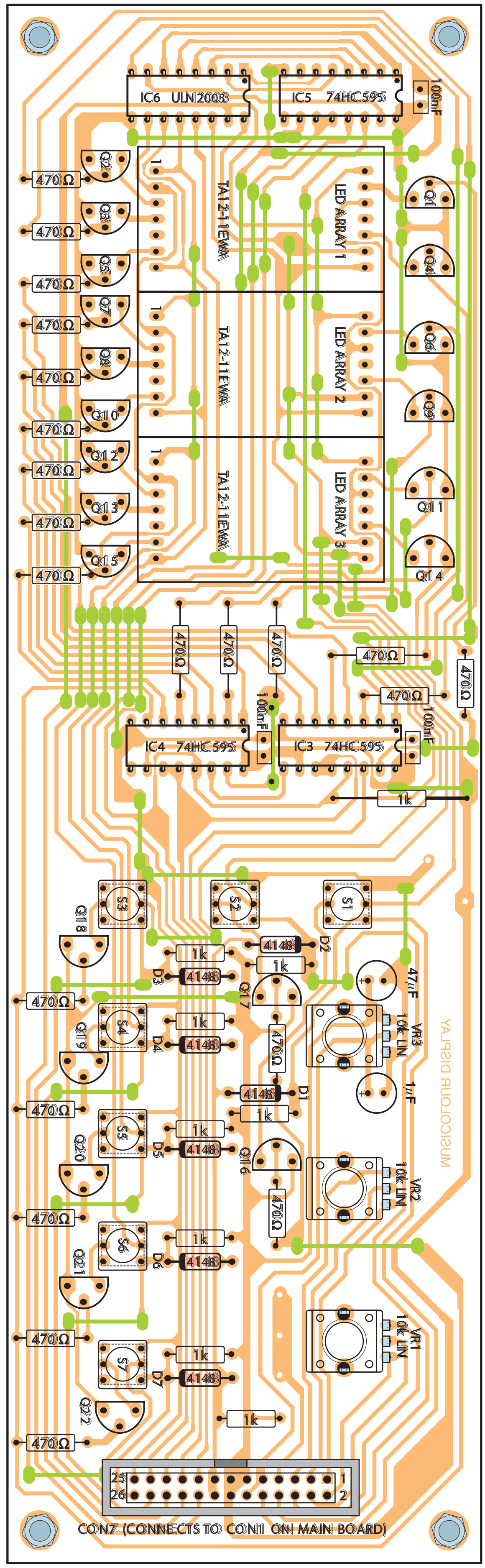
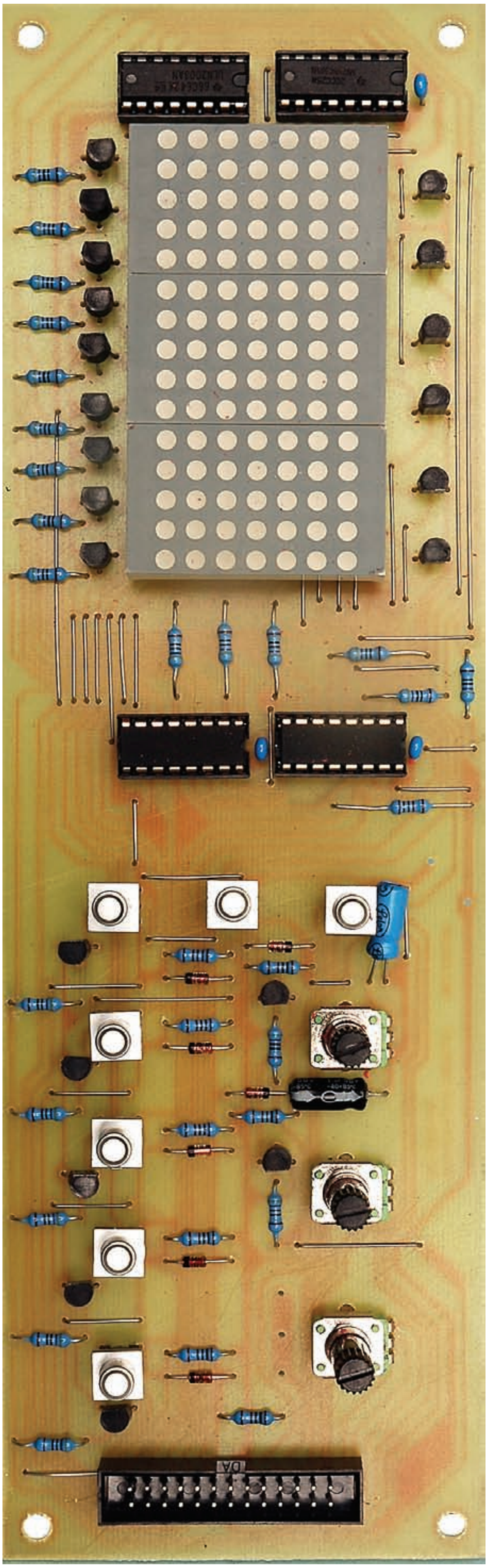


Fig.1: component overlay for the display PC board, with a matching photo opposite. Start assembly with the display PC board as detailed in the text. The top layer of the PC board is shown in green – if you etch your own (single-sided) board, the green tracks will need to be replaced with wire links, with holes drilled in appropriate places.



For 230V-240V operation, you should only install link LK2 and leave out LK1 and LK3, under the transformer. For 110V to 120V operation, you should install links LK1 and LK3 and leave out LK2.

You must never install all three links LK1, LK2 and LK3 at the same time. This will short the mains supply and blow the fuse and possibly trip the circuit breakers in your home!

Make sure you have installed LK2 (for 230V-240V) or LK1 and LK3 (for 110V-120V) correctly before proceeding.

There is an optional link near the two 270Ω 1W resistors and CON2. This is shown as LK4 on the main circuit (Fig.2) in last month's issue, and this will normally be omitted. Its operation will be explained in next month's article.

Next, you can move on to installing the resistors. Again, check each value against the component overlay diagram of Fig.3 and with your digital multimeter.

There are seven diodes on the board, and it is vital that they are oriented correctly. Diodes D11 to D14 are 1N4004, while D8-D10 are 1N4148. Notice that diodes D11 to D14 (the bridge rectifier) are *not* all oriented the same way (their orientation alternates).

Once the diodes are conected, you can solder in the two IC sockets; the 40-pin socket for IC1 and the 16-pin socket for the LM324 quad op amp (IC2). Make sure these are oriented correctly as per the component overlay.

Next, solder in the four optocouplers (MOC3021). These are 6-pin devices and it is vital that they be oriented correctly, with their pin 1 on the low voltage side of the board.

The capacitors go in next. The MKT and monolithic capacitors are not polarised, but the electrolytic capacitors are and you should refer to the component overlay to install them correctly.

The four 100nF X2-type 250V AC capacitors on the mains side of the board must be soldered in so they are sitting flush, ie, without any of their leads being exposed.

Next, to install the LM317T regulator REG1, bend the leads by 90° before threading them through the holes on the board. Then fasten the tabs to the TO-220 mini heatsink and to the main board using one M3 10mm screw and one M3 nut. Do this before soldering the leads, as the stress of tightening the tab could cause cracks in the solder joints if the regulator is soldered in first.

The 3mm red LED (LED8) can be installed next. This must be oriented correctly with its flat side as shown on the component overlay.

The two 2-pin jumpers labelled LK5 and LK6 on the component overlay can be made from the 28-pin header terminal strip, and soldered in. They will accept optional jumper shunts.

You should also take two single pins from the 28-pin header terminal strip and solder these in for the two test points TP0 and TP1, near regulator REG1. The test points will be used to measure the input

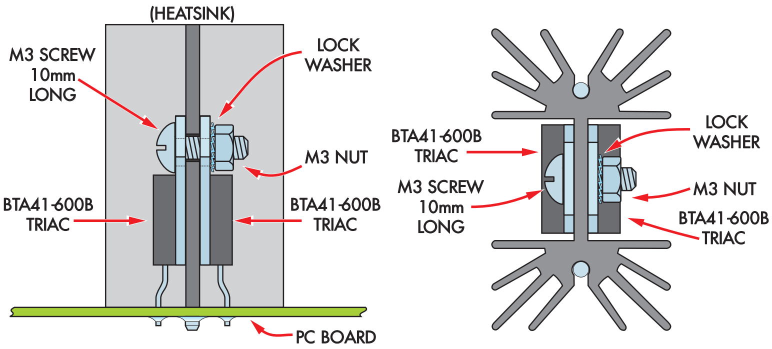


Fig.2: elevation (left) and plan (right) views of how the triacs are mounted to the double-sided heatsinks (two triacs to each heatsink). Use an M3 metal screw (10mm) and an M3 nut.

and output of the regulator, as will be explained below. After that, you can install the electret microphone insert, again making sure that it is oriented correctly.

Next, install the 26-way IDC header, as shown on the component overlay. This has a keyway on its side, which should face the microcontroller.

CON2 consists of a 2-way and a 3-way mini terminal block slotted into each other to make a 5-way terminal block.

Two 2-way terminal blocks CON4 and CON5 and the 3-way terminal block CON6 should be soldered in next. Their screw terminal inputs should be facing the *back* edge of the main board.

You can also solder in the four 100μH chokes (these **must** be rated at 5A) which sit vertically on the main board. As these are wound with enamelled copper wire, you should ensure that the terminals have been properly stripped and tinned before you attempt to solder them in place.

Installing the triacs

Once that is done, you are ready to solder in the four triacs. It is most important that these are insulated tab types, which is why BTA41-600B are specified. **You should use a multimeter and measure the resistance from pin 2 (the middle lead) of each of the four triacs to their metal tabs. This should indicate a very high resistance or open circuit.** On the other hand, if it indicates a low resistance or short circuit you probably do not have the correct triac and you should not proceed.

Once you have verified that the triacs have insulated tabs, attach two to each double-sided heatsink using an M3 10mm screw and M3 nut as shown in Fig.2. Notice that the tabs of the triacs are in direct contact with the heatsink.

It is then a matter of sliding the heatsink with the two attached triacs onto the PC board. The heatsink has two mounting pins to locate them on the PC board. You can then solder the two triacs in place. Repeat this for the other pair of triacs.

The construction of the main board is now complete as regards to soldering in components. The only component missing is the potted mains transformer.

Final main board construction

At this stage, it is prudent to go back over your work and make sure everything looks in order by comparing your populated board with the component overlay.

If you are absolutely satisfied that you have installed or omitted LK1, LK2 and LK3 as per the instructions (depending

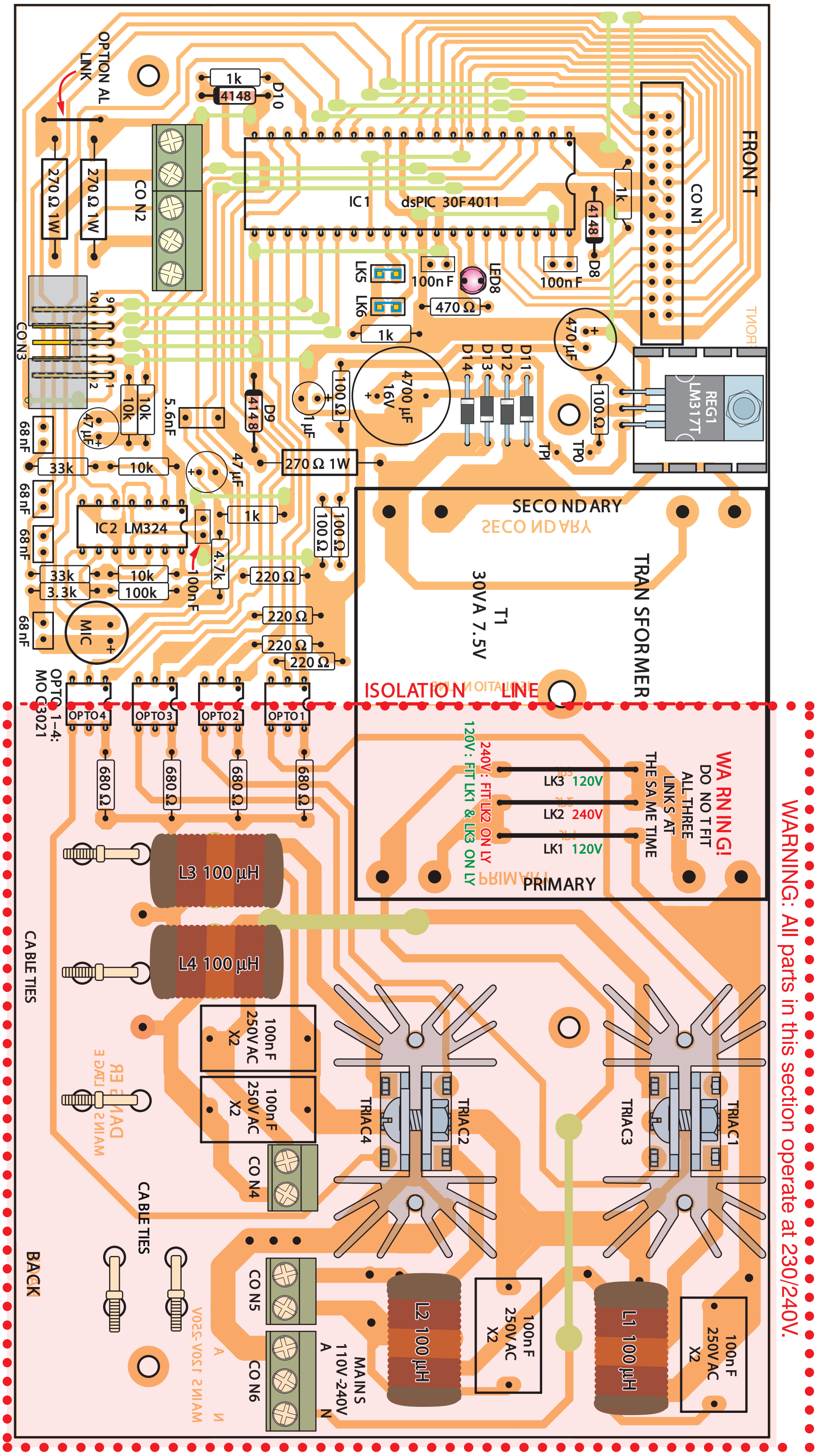
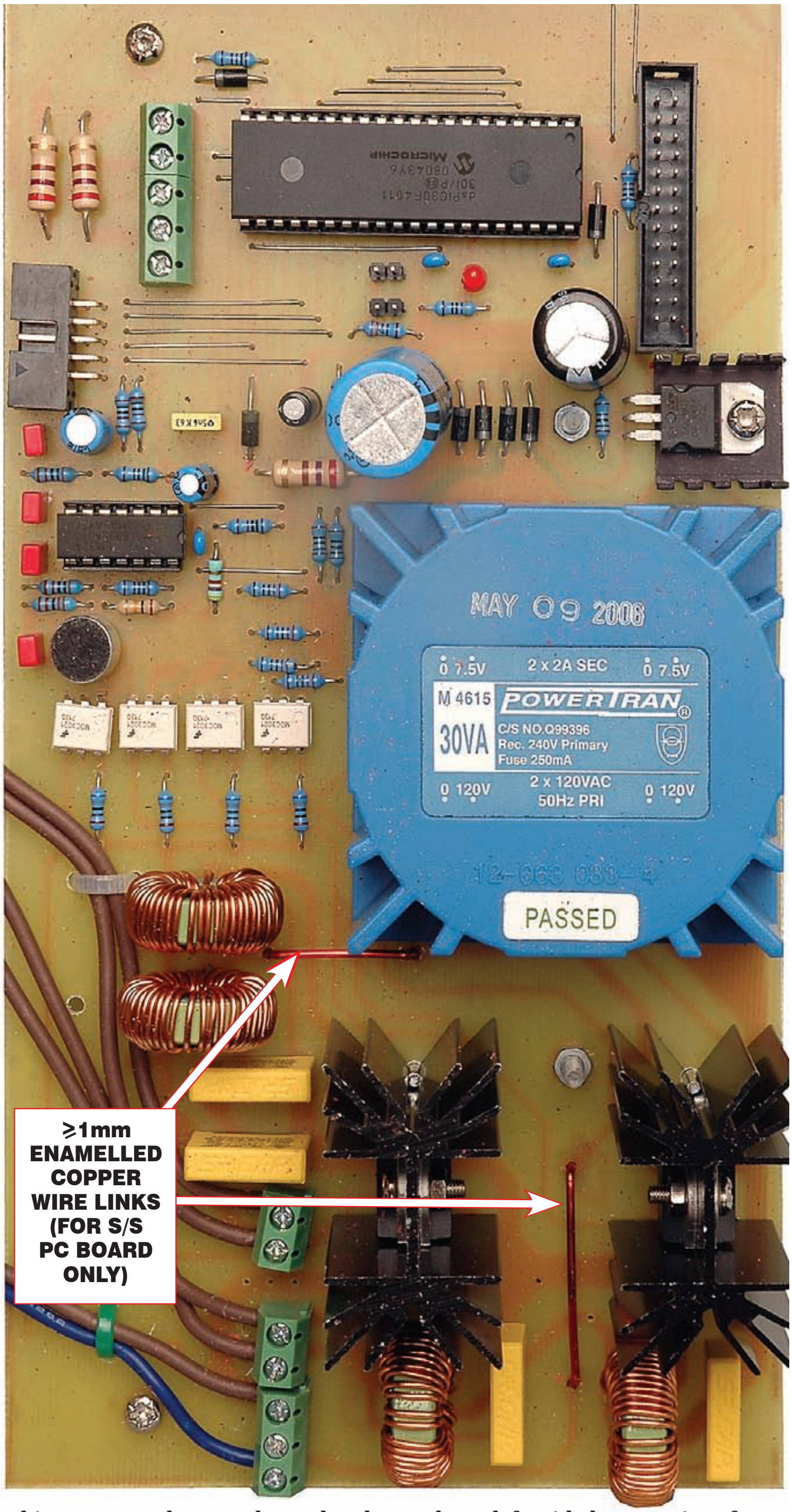


Fig.3: component overlay for the main board, which includes all the mains-potential circuitry (apart from the input/output IEC sockets). The top (component) side of the PC board is shown with green tracks; the bottom side in the usual copper colour. The dotted area above shows the section of the PC board which has components and tracks at mains potential. Never operate the DSP Musicolour unless it is inside its case with the lid screwed on.



This prototype photograph matches the overlay at left, with the exception of most of the wire links which have now been replaced by tracks on a double-sided board. Again, if you etch your own single-sided board, the links will be required. In the case of the two heavy enamelled copper wire links in the mains section of the board (arrowed above), make sure you use similar heavy enamelled copper wire – for safety's sake!

on the mains voltage in your area), it is time to solder in the mains transformer.

This should only fit one way and its primary and secondary sides should be clearly marked. The secondary side should point towards the low voltage side of the circuit, while its primary side should point towards the two heatsinks holding the four triacs.

You should attach the transformer to the main board using an M4 screw before soldering the leads. The screw will need to be threaded from the copper side (bottom side) of the board and holds the heavy transformer in place (the screw hole is the one in the middle of the transformer, just to the left of LK3 on the component overlay). Now solder the transformer in place.

Installation instructions

If you have followed these instructions, you should now have an assembled display board with its four ICs in their sockets and a 26-way ribbon cable plugged into it with its other end as yet unconnected. You should also have an assembled main board with all components soldered and with IC1 and IC2 out of their sockets for now.

Notice that the specified case (see parts list) is not symmetrical, and so the main board has indicators 'FRONT' and 'BACK' on the component overlay, indicating the back and front panels.

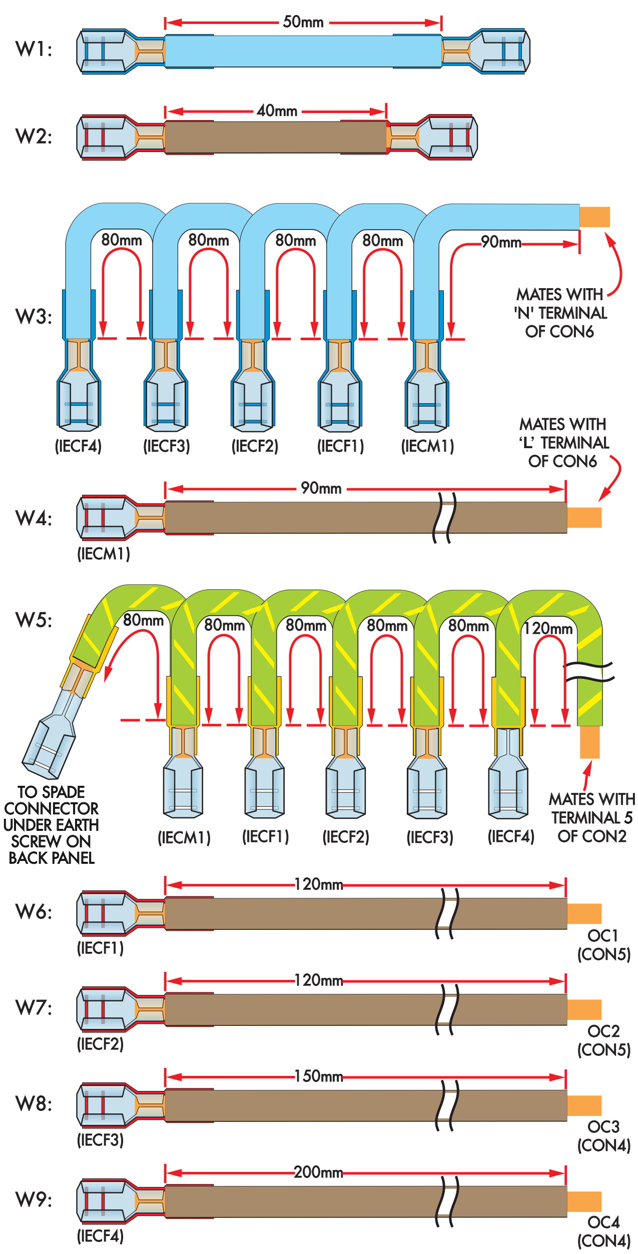
Attach the main board to the case using the four mounting holes and M3 10mm screws. The two lower screws attach directly to the case while the top two screws should be attached using two 3mm × 15mm nylon spacers, cut to 8mm long and with longer M3 nylon 25mm screws. The spacers are used to provide support to the main board when it is in the case. You will need to drill two 3mm holes in the bottom of the plastic case to thread these through, as shown in Fig.7. You can then attach them to the PC board using M3 nuts (also shown in Fig.7).

Once the main board has been attached to the case, continue by installing the appropriate fuse inside the male IEC socket; 10A (for 230V to 240V operation) or 15A (for 110V to 120V operation).

You will now need to make up some connections for the back panel, using the individual cables from the 1m length of three-core mains flex cable, spade lugs and a crimping tool. (The three-core mains cable is used to ensure sufficient voltage rating for these mains-carrying connectors).

First, remove the outer insulation from the three-core mains flex and use the brown, blue and green/yellow wires, following Fig.4, which details the lengths of

The rear panel of the DSP Musicolour sports the IEC power input socket with integral fuse and mains switch (far right); the four IEC controlled output sockets (centre); 6.5mm audio input socket and stereo audio (speaker level) input sockets (far left). If the speaker level input sockets are used, they're designed to go in parallel with existing speakers.



the wires you need to make. These are labelled W1 to W9 in Fig.4 and these numbers will be referred to below.

All these crimps need to be done carefully to ensure the connections are tight between the spade lugs and the wire. Don't be tempted to use an automotive-type crimper – they're not strong enough to produce a quality crimp and your wires could come out of the spade lugs. You need a good quality ratchet-type crimper and good quality spade lugs.

Back panel installation and wiring

The back panel is made of steel and kits should be supplied with all holes punched and drilled. Snap in the male IEC socket (with the fuse installed, as explained previously) and the four female IEC sockets, as well as the optional microphone jack and audio speaker terminal block. The audio speaker terminal block is attached using two nylon M3 12mm screws with two 3mm × 6.3mm nylon spacers used as nuts.

Next, install the 'earth' spade lug on the back panel using an M3 × 10mm screw, shakeproof washer and two nuts (see Fig.5). Later, these will be used to earth the back panel. Check with a DMM that the screw is electrically connected to the back panel (ie, 0Ω or very close). You may have to scrape some paint away under the nuts to ensure intimate contact.

Install the back panel in the case and use the display board with its attached plastic front panel as the front panel (but without yet connecting the display board to the main board using the 26-way ribbon cable).

Install connecting cables W1 to W9 as shown in the wiring diagram for the back panel (see Fig.6). The insulated spade lugs are colour coded so that the brown should indicate Live while blue indicates the Neutral mains connection. A green/yellow cable is used for the Earth connection. Follow the wiring diagram carefully to complete the wiring of the back panel.

You should be left with seven loose wires from W1 to W9. One green and yellow end of W5 connects to pin 5 of CON2, as explained in the section on 'earthing'. The other six loose ends of W3 to W9 connect to CON4, CON5 and CON6 terminal blocks, as shown in wiring diagram Fig.6.

Make all these connections, paying particular attention to the earthing instructions. Also, use the holes on the main board

Fig.4: you will need to make up several crimped connector cables for the DSP Musicolour. This diagram shows the various types, colours and lengths.

DSP Musicolour Parts List

Main Board and hardware

* 1 PC board, coded 759, size 221mm × 165mm
1 Case (Altronics H0482 – **www.altronics.com.au**) with steel panel punched for IEC sockets
1 Transparent red acrylic front panel, 254 × 75 × 3mm with silk-screen labelling and drilled to suit
1 30VA 120V-240V, 7.5+7.5V sec. potted toroidal transformer (Altronics M4615 – **www.altronics.com.au**)
1 Chassis male IEC socket with switch and fuse (Jaycar PP4003)
1 IEC female power lead 240VAC (Jaycar PS4106)
4 IEC male to 3-pin (GPO) socket (Jaycar PS4100) (optional)
4 Chassis female IEC sockets (Jaycar PS4002, Altronics P8327)
1 10A 3AG fast blow fuse (Jaycar SF2204)
1 26-way IDC header
1 10-way right-angled IDC header (optional)
1 0.15m x IDC ribbon cable 16-way (Jaycar WM4502) (optional)
2 IDC line sockets 10-way (Jaycar PS0984) (optional)
3 2-way mini PCB terminal blocks – 5mm spacing
2 3-way mini PCB terminal blocks – 5mm spacing
7 6.4mm blue insulated spade lugs (Jaycar PT4625)
7 6.8mm red insulated spade lugs (Jaycar PT4525)
5 6.8mm yellow spade lugs (Jaycar PT4707)
1 1m 3-core mains flex 10A (Jaycar WB1562)
Wire for connecting audio socket
1 6.5mm audio mono chassis socket (Jaycar PS0162)
1 4-way speaker terminal block (Jaycar PT3002)
1 40-pin IC socket
1 16-pin IC socket
6 M3 screws 10mm long
1 M4 screw 10mm long
7 M3 nuts
2 Nylon M3 screws 12mm long (Jaycar HP0140)
2 Nylon M3 screws 25mm long (Jaycar HP0142)
4 Tapped nylon spacers 3mm × 6.3mm (Jaycar HP0920)
2 Heavy duty TOP-3 (ML97 type) heatsinks (Jaycar HH8526)
1 TO220 mini (6073B type) heatsink
2 Jumper shunts
1 28-pin header terminal strips
1 1m tinned copper wire (Jaycar WW4032)
1 0.15m enamelled copper wire (1mm thick) (Jaycar WW4022)
1 electret microphone insert
4 100µH 5A toroid suppression chokes (Jaycar LF1270) (L1 to L4)

* PC boards (single-sided) available as a set from the *EPE PCB Service*

Semiconductors
1 LM317T 3-pin adjustable voltage regulator (REG1)
1 dsPIC30F4011 microcontroller, pre-programmed (IC1)
1 LM324 quad op amp (IC2)
4 BTA41-600B insulated tab triacs – see text
4 MOC3021 optocouplers
3 1N4148 diodes (D8-D10)
4 1N4004 diodes (D11-D14)
1 3mm red LED (LED8)

Capacitors
1 4700µF 16V radial electrolytic
1 470µF 16V radial electrolytic
2 47µF 16V radial electrolytic
1 1µF 16V radial electrolytic
4 100nF 250V AC X2 style, 15mm pitch metallised polypropylene
3 100nF monolithic
4 68nF MKT
1 5.6nF MKT

Resistors (0.25W 1%, unless specified)

4 100Ω	4 220Ω	3 270Ω 1W	1 470Ω
4 680Ω	4 1kΩ	1 3.3kΩ	1 4.7kΩ
4 10kΩ	2 33kΩ	1 100kΩ	

Display Board

* 1 PC board, code 760, size 247 mm × 76 mm
3 Kingbright TA12-11EWA red 5×7 dot matrix LED modules
3 10kΩ linear 9mm 18T spline shaft single rotary pots (Jaycar RP8510, Altronics R1946)
3 push-on 18T spline knobs to suit (Jaycar HK7730/31/32; Altronics H6510)
3 SPST vertical PC mount tactile switch with LED (red) (Jaycar SP0612)
4 SPST vertical PC mount tactile switch with LED (blue) (Jaycar SP0614)
1 26-way IDC header
4 16-pin IC sockets
3 14-pin IC sockets (cut in half)
4 Nylon screws M3 25mm
8 Tapped nylon spacers 3mm × 15mm
1 26-way 0.15m × IDC ribbon cable
2 26-way IDC line sockets
1 2m tinned copper wire (Jaycar WW4032)

Semiconductors
3 74HC595 shift registers (IC3 to IC5)
1 ULN2003 line driver (IC6)
7 1N4148 diodes (D1 to D7)
22 BC327 *PNP* transistors (Q1-Q22)

Capacitors
1 47µF 16V electrolytic
1 1µF 16V electrolytic
3 100nF monolithic

Resistors (0.25W 1%)
22 470Ω   9 1kΩ

for attaching these wires solidly to the main board using cable ties. **You should also use cable ties around each of the three wires connecting to each female IEC socket. This is particularly important to hold the wires in place, especially since two of the female IEC sockets sit above the low voltage part of the main board.** Should the live connection to one of these come off, the cable ties should ensure that they do not fall onto the low voltage section of the main board.

Once you have attached the cable ties as shown in Fig.6 and the photographs you should proceed to the earthing section below.

Earthing

Connect the green/yellow earth wire (W5) as shown in the wiring diagram in Fig.6 so that the earth of the male IEC socket connects to the earths of all the female IEC sockets and the crimped connector which is fastened to the earthing screw on the back panel, as shown at right (Fig.5). The remaining end of W5 should connect to pin 5 of CON2 (the 5-way terminal block) as shown in Fig.6.

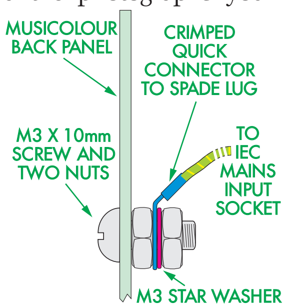


Fig.5: the green/yellow earth wire must be securely connected to the back panel via a crimped spade connector and an M3 screw with two nuts and a star washer.

Do not proceed unless you are satisfied that W5 connects all these points to the male IEC socket's earth terminal (the middle terminal). Again, you should use a multimeter or continuity tester to make sure that all these points (including chassis earth) are electrically connected (0Ω or very close).

Preliminary power supply check

Once you have done that, it is time to check the power supply rails before final assembly. To do this, solder two wires to the two test-point stakes (TP0 and TP1) near REG1 and use pin 1 of CON2 as the GND reference. The wires should be long enough to leave the case and be accessed from outside the case. You can thread them through the hole used to mount the microphone jack on the back panel.

Now close the case – attach the top half and screw in the two screws to seal it.

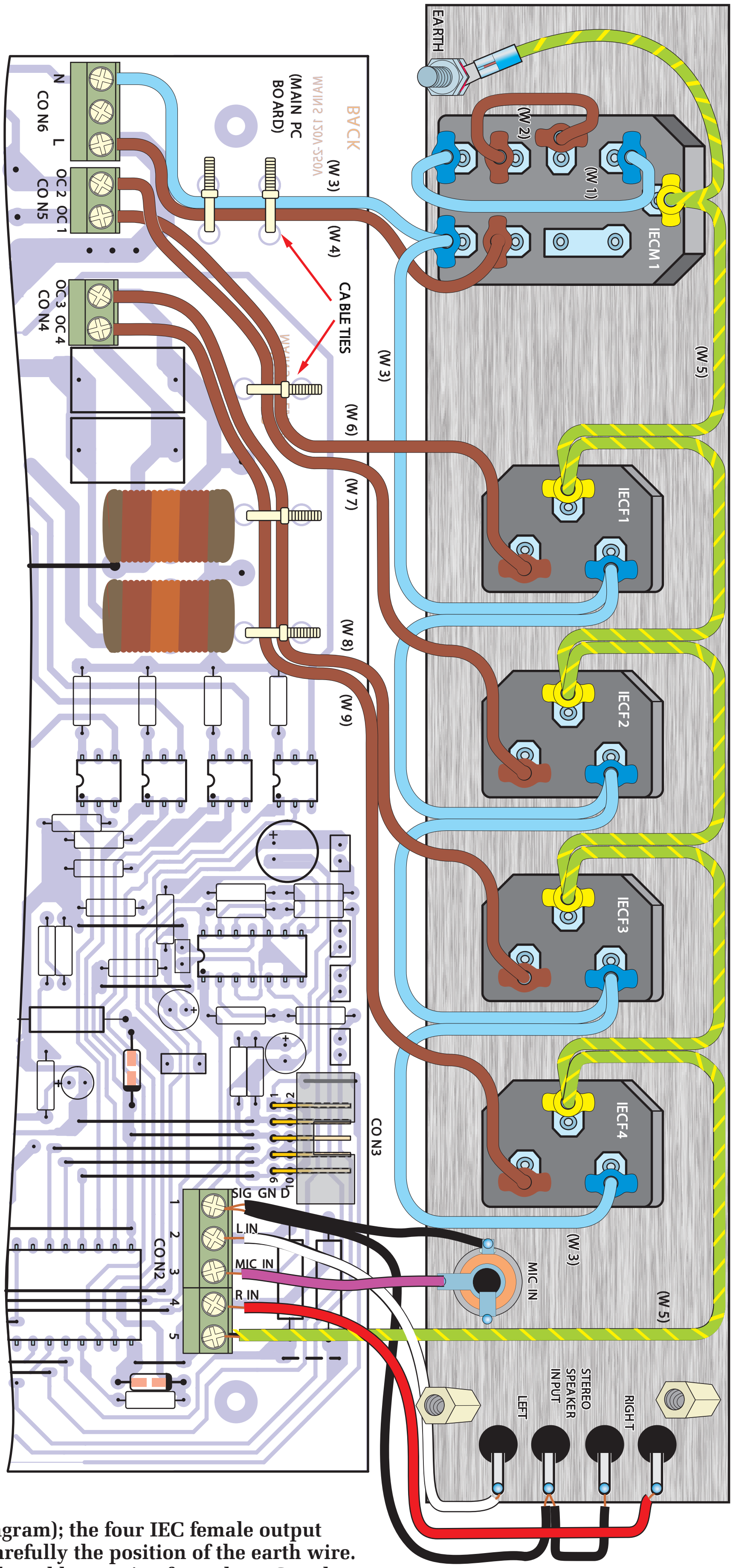
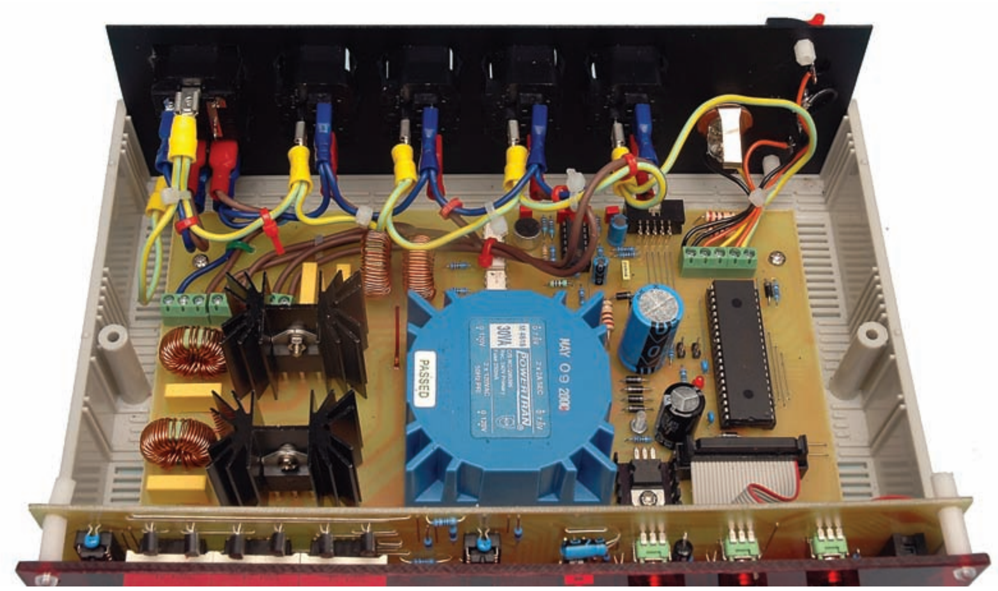


Fig.6: here's the other side of the back panel, showing the wiring between the IEC mains input socket/fuse/switch (top in this diagram); the four IEC female output sockets (IECF1 to 4) and the PC board. Note carefully the position of the earth wire. Not shown here are the cable ties around all the cables coming from the IEC sockets (male and female). These are important safety items and should not be overlooked (see photo above right).



Looking from front to rear, the mains wiring can be clearly seen. All wiring here is mains rated – the easiest way to ensure this is to use lengths of cable stripped from a scrap of mains-rated flexible lead. Don't forget the cable ties: they're just in case!

You should only proceed if the case is closed, the back and front panels have been installed, the back panel has been wired correctly, as shown in Fig.6, and the back panel has been properly earthed as described earlier. Notice that at this stage, the display board is not yet connected to the main board using the 26-way ribbon cable, and that IC1 and IC2 on the main board are still out of their sockets. Also, the audio terminal block and the microphone jack on the back panel are not yet connected.

You can now apply power using an IEC power cable and by flicking the switch on the male IEC socket to the ON position. You should measure the voltages at TP0 and TP1 relative to the GND wire using a multimeter.

Normal levels should give around +10V DC on TP1 and +5V DC on TP0. If the level on TP1 is not close to +10V you should disconnect power immediately and recheck your work.

If the voltage at TP0 is close to +5V it indicates that you are on the right track. If the voltage at TP0 is much different from +5V (note that anything from +4.8V to +5.2V is actually OK) then there is something wrong and you should recheck your work. Check that diodes D11 to D14 are oriented correctly. Check that REG1 is correct and the resistors associated with REG1 are indeed 100Ω. Check that the large 4700µF electrolytic is correctly installed and that all the other electrolytics are correctly oriented according to the component overlay.

Final Assembly

If (and only if) the voltages at TP0 and TP1 are OK, then proceed. First, switch off mains power and disconnect the mains cord. Once you are absolutely certain there is no mains power being supplied, open the case. Unsolder the two wires attached to TP0 and TP1 and also remove the GND connection at pin 1 of CON2. These are no longer needed.

Install IC1 and IC2 on the main board IC sockets. Make sure they are oriented correctly. IC1 should be programmed with the latest version of the firmware. If you are building the DSP Musicolour from a kit, IC1 will be pre-programmed. If you are not, CON3, the optional10-way IDC header can be used to program IC1 using an external connection. More on this next month.

Now connect the audio speaker terminal block by soldering four wires onto the audio speaker terminals, and connecting them to the terminal block CON2. Also solder wires to the microphone jack and connect these to CON2. Fig.6 shows this connection (among others).

Connect the 26-way ribbon cable from the display board to the main board (CON1 on the main board). The photo above shows the completed assembly (showing an early but similar prototype) just before closing the case. Close the case of the lid and screw it shut. Your DSP Musicolour is now fully assembled.

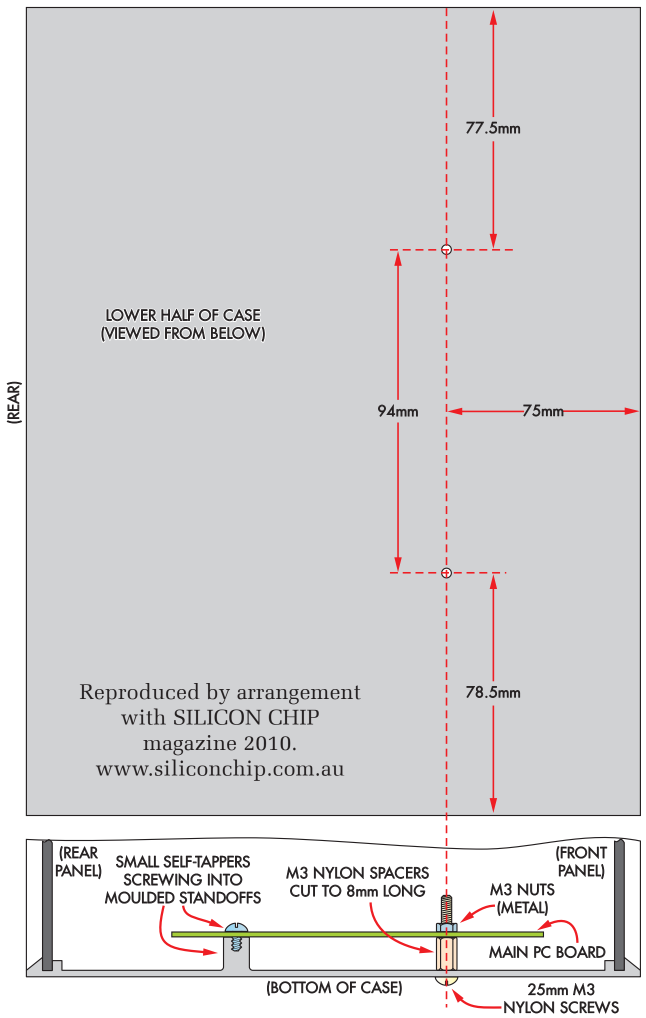


Fig.7: this scaled drawing shows how the main board is secured in the case (note the use of nylon spacers and screws for safety).

In next month's article we will explain the user menus and the operating instructions for the DSP Musicolour, as well as calibration instructions – stay tuned.

Recycle It!

BY JULIAN EDGAR

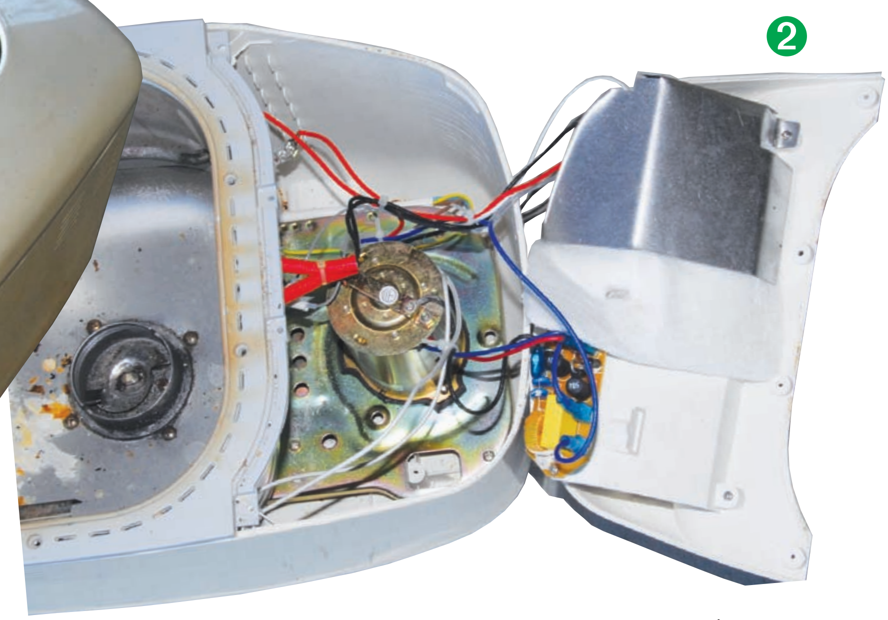
Breadmakers and Fan Heaters

Small consumer goods like breadmakers and fan heaters often pop up free of charge. So is it worth pulling them apart for the good bits inside?
Perhaps surprisingly, while the parts that can be salvaged aren't as numerous as you'll find in bigger items (like photocopiers), breadmakers and fan heaters are often easier to find and always much easier to transport home!

Breadmakers – save some dough

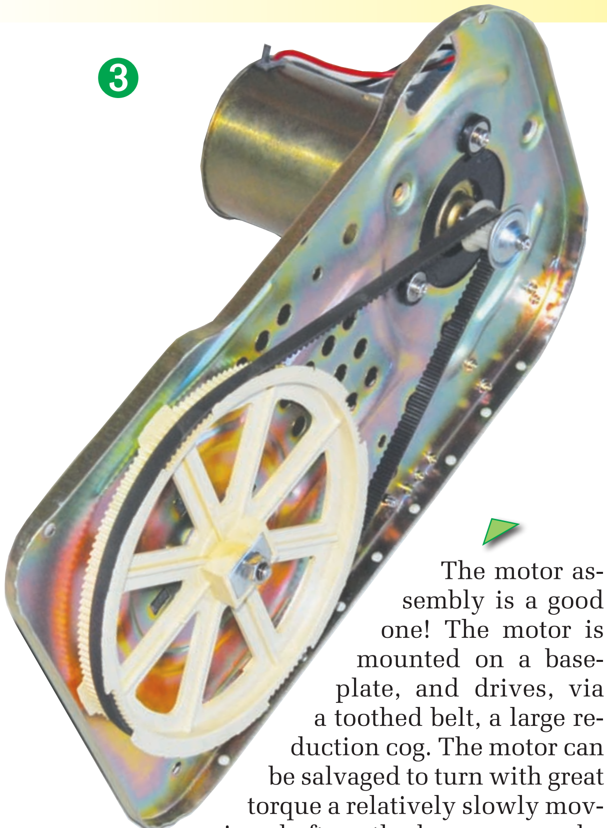
1

2



THE guinea pig was a Breville design, and here it is, complete with external dirt and – as I later found – still with old bits of cooked bread inside! The front panel controls set the heat of the cooker (provided by a wrap-around element), the speed of the mixer, and the time for which the machine will run.

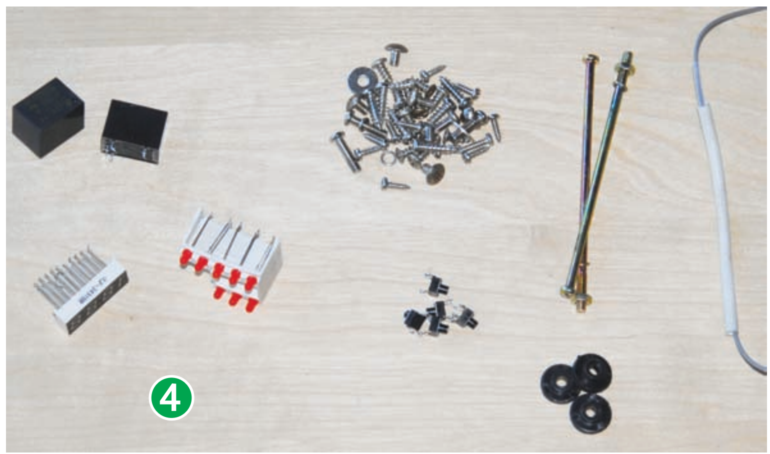
A few self-tapping screws to remove and then the drive motor could be seen. It's a brushed (ie, universal) design, rated at 50W and mains voltage. Note that all the wiring that can be seen here is covered in high temperature, braided insulation – perfect for salvaging for any high temperature use.



The motor assembly is a good one! The motor is mounted on a baseplate, and drives, via a toothed belt, a large reduction cog. The motor can be salvaged to turn with great torque a relatively slowly moving shaft, or the large cog can be rotated to drive the motor very fast!

The latter is good for a hand-cranked generator; the former for any application where a slow rotation is needed. Don't forget that because it's a universal motor, it will work on AC or DC, and will rotate more slowly as the drive voltage is reduced.

Let's not forget the small components. By the simple expedient of putting aside the screws as they were removed, a bunch of self-taping screws were collected. Also salvaged were two 24V relays, a digital display, eight LEDs, five miniature push-buttons, some long bolts, three rubber washers and an NTC thermistor. (Don't forget, it takes only seconds to remove electronic components if you use a heat-gun on the solder side of the PCB and a pair of pliers to pull the component out as the solder melts.)



Rat It Before You Chuck It!

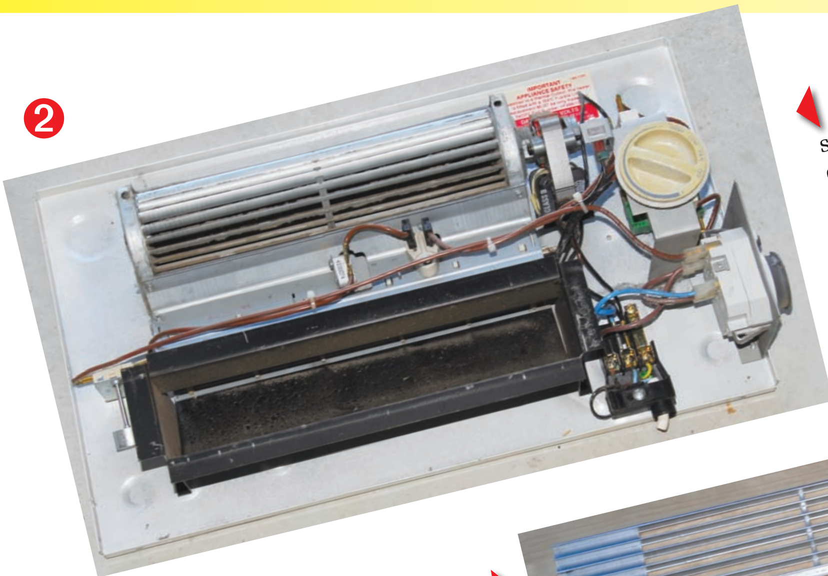
Whenever you throw away an old TV (or VCR or washing machine or dishwasher or printer) do you always think that surely there must be some good salvageable components inside? Well, this column is for you! (And it's also for people without a lot of dough.) Each month we'll use bits and pieces sourced from discards, sometimes in mini-projects and other times as an ideas smorgasbord.

And you can contribute as well. If you have a use for specific parts which can easily be salvaged from goods commonly being thrown away, we'd love to hear from you. Perhaps you use the pressure switch from a washing machine to control a pump. Or maybe you have a use for the high-quality bearings from VCR heads. Or perhaps you've found how the guts of a cassette player can be easily turned into a metal detector. (Well, we made the last one up, but you get the idea . . .)

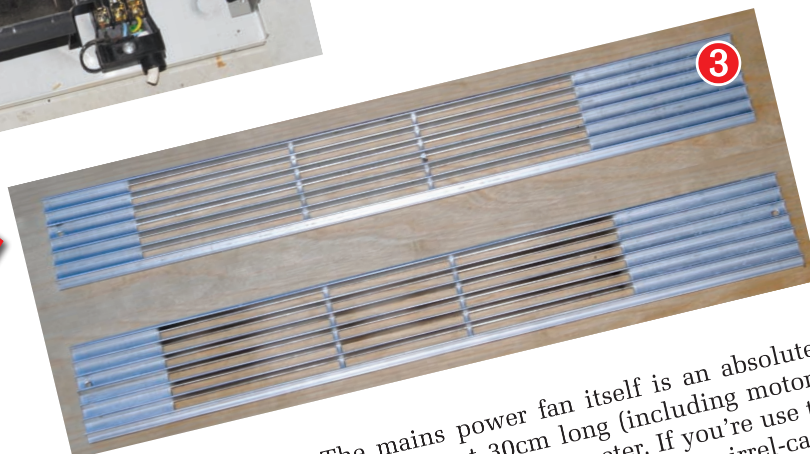
So, if you have some practical ideas, do write in and tell us!

Fan Heaters – no sweat

The fan heater was a Skope 2400. This design provided adjustable fan speed and heating, and had a timer built in. Opening-up the cabinet also revealed some unexpectedly good bits!

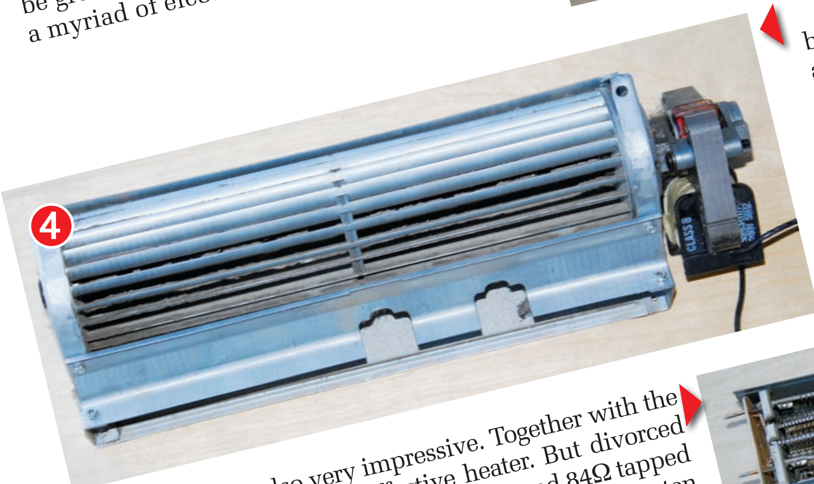


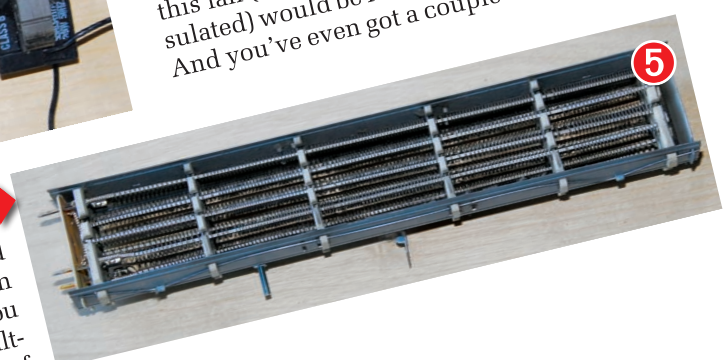
As well as a lot of dust, looking inside the case revealed a nice squirrel-cage fan and attached mains power AC motor; the timer (that was a labelled, standalone design); a heater element, over-turning switch; terminal block; high current resistor and – but we're getting ahead of ourselves.



These aluminium grilles were easily unscrewed from the front panel. They're made of extruded aluminium and would be great (perhaps with the ends cut off) in a myriad of electronic equipment.

The mains power fan itself is an absolute beauty – about 30cm long (including motor) and about 70mm in diameter. If you're use to axial (PC-type) fans, these long squirrel-cage designs are a revelation, in that they move a lot of air – and are often very quiet. I've used a slightly smaller one in a home amplifier, and this fan (suitably mounted with the wiring insulated) would be ideal in large electronic gear. And you've even got a couple of grilles to suit!





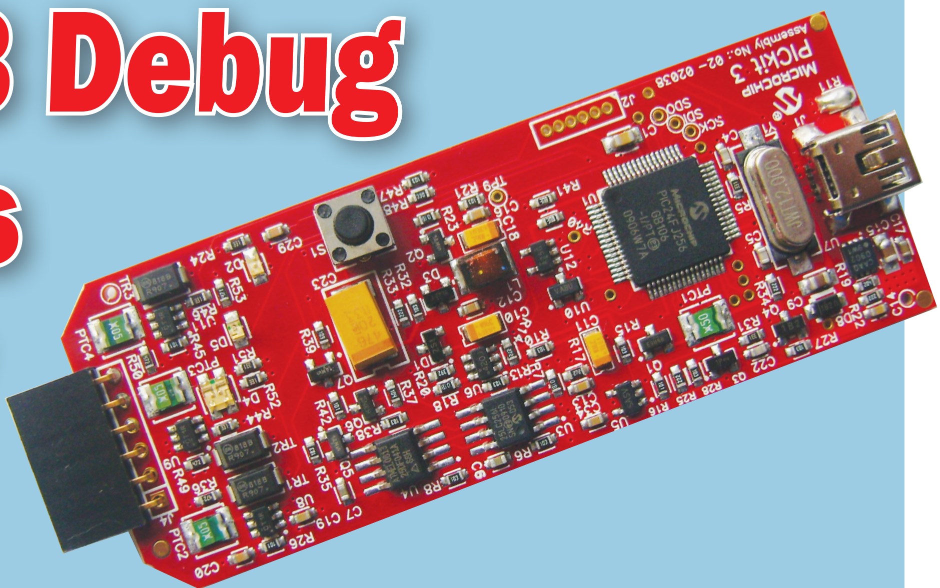
The heater element is also very impressive. Together with the fan, you (of course) have a very effective heater. But divorced from the fan, you have a large resistor with 42Ω and 84Ω tapped resistances. With a bit of judicious disassembly, you can shorten (or parallel) the windings to give you any lower resistance you want – and all on high-temperature ceramic formers. The resulting resistor is ideal for testing amplifiers, or as a quick means of dropping the speed of a low-voltage motor.

Finally, there are the smaller bits and pieces. From top-left and then clockwise: the over-turning switch (ideal as a means of switching something with the acceleration or braking of a vehicle); a mechanical room temperature thermostat; a 470Ω 20W ceramic resistor; a standalone timer; a red mains power neon with bezel; a knob (although it looks nothing special, I collect these because they suit a D-shape shaft, which is unusual but useful); and a high-temperature mechanical thermostat.

Conclusion

As always, disassemble the goods as soon as you get them, sort and keep the bits you want, then get rid of the rest. It's surprising what fun it is – especially if you have an inquisitive child to help you – and the resulting parts can be put to a bunch of uses. ***EPE***

PICkit 3 Debug Express Review



by Mike Hibbett

Facing up to the future with Microchip's PICkit 3

The PICkit 3 is the latest in the series of low-cost programmer/debugger devices manufactured directly by Microchip. Microchip have been manufacturing processor emulators and programming hardware since they entered the processor market, so they've had plenty of practice, and we've been eagerly awaiting the arrival of a new low-cost device.

We reviewed its predecessor, the PICkit 2 last year, so this should be an interesting opportunity to take a look at what is essentially a design refresh, and to see how things have changed, and hopefully improved.

The next generation

So what exactly is the PICkit 3? It is (we believe) the next generation of combined device programmer and debugger, intended to replace the PICkit 2. When connected to a PC, it can program PIC processors in-circuit via an ICSP (in-circuit serial programming) header. It can also take control of the microprocessor and single-step programs directly on your target PCB. In short, exactly what the PICkit 2 could do.

As you can see from Fig. 1, it's packaged exactly like a PICkit 2. On closer inspection, the similarities continue as the device's plastic enclosure is identical in shape and size, albeit in a funky transparent red plastic material, making the PCB inside visible. Fig. 2 shows how this change has made the PICkit 2 looks dated and cheap by comparison. But we are not here for a beauty pageant; it's the functionality that's important.

Fig.1. PICkit 3 comes in a 'bubble-pack'

Future proof

Inside the PICkit 3 (Fig. 3) the circuit board is very similar to its predecessor's, only now the embedded processor is a much more powerful PIC24 device – the PIC24FJ256GB106. This processor has an on-chip USB interface for the connection back to the PC, and comes with 256KB of flash memory, and a 16-bit core CPU.

Microchip has clearly gone for a powerful processor to provide a future proof design, capable of coping with the new range of high specification processors such as the PIC32. The PCB is also fitted with much more external serial flash memory – a 512KB part – due, no doubt, to the popularity of the 'programmer on the go' feature of the PICkit 2, which allowed it to program chips without a PC connected.

Needless to say, the faster processor and larger memory has resulted in a price increase over the PICkit 2, but not by a significant amount. The PICkit family of programmers remain exceptional value for money, although our view may be tainted by memories of spending in excess of £1000 on a PIC emulator back in the late 1980s. We really are spoilt these days!

What's in the package

Inside the blister-pack is the programmer, a USB lead to connect it to your PC, a CD and a demonstration circuit board.

The demo board, shown in Fig. 4, is again very similar to the board supplied with the PICkit 2. There is a pleasant surprise, however: it's been upgrade from a 16F619 processor to a PIC18F45K20. That's quite a versatile little processor, and is supported by the Microchip C18 compiler – our favorite free PIC C compiler.

If you are just starting out with learning C for embedded processors, then this would be a great place to start. Everything you need is included in the pack, as the demo board can be powered from the PICkit 3 via the PC's USB interface. There are eight small surface mounted LEDs, a variable resistor (for hooking up to the analogue-to-digital converter) and a reasonably sized prototyping area on the board, so room for experimentation. This board is one of many different demonstration boards that microchip produce, so unless you are looking for an immediate hardware 'kickstart', you might consider purchasing the PICkit 3 device by itself.

Fig.2. Comparison with PICkit 2

Tooling up

The CD supplied in the pack contains a selection of useful tools, all freely available for download from the Microchip website. Unless you have a slow Internet connection, you will be better off downloading the latest MPLAB from the website, as the CD will naturally be somewhat out of date, especially given Microchip's excellent approach of frequent software updates. Our CD came with MPLAB v8.30, so it's almost a year old.

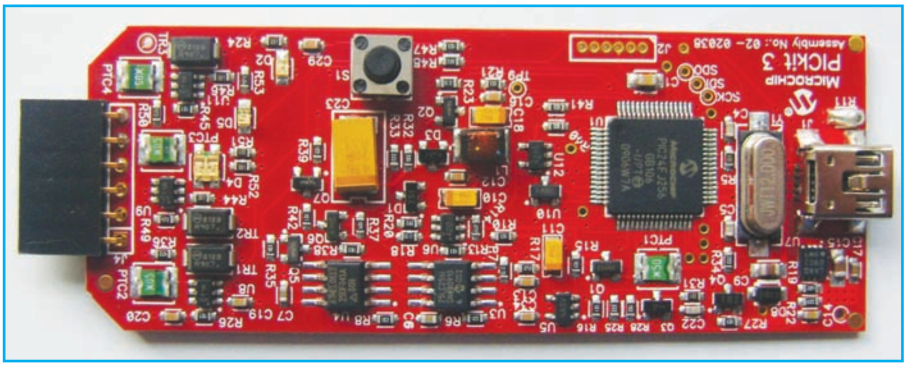


Fig.3. PICkit 3's populated printed circuit board

It is, however, still worth looking around the CD, as there are some interesting items that you may miss on the website. There are some video files that are presentations by Microchip on various technical subjects. Worth a look if you have a spare hour or two.

If you have a fairly recent version of MPLAB already installed (v8.30 or later), then you can pretty much forget the CD, as all the software drivers required will have already been installed. Using the PICkit 3 is as simple as plugging it in, waiting for your PC to recognise the new device and then selecting 'PICkit 3' from the Programmer menu option in MPLAB.

In use

If you have used a PICkit 2 before then you are going to discover that the PICkit 3 has some annoying features in it's operation. Every time a device family is changed (say, from PIC16 to PIC18) MPLAB downloads new firmware to the PICkit 3, which can take 20 to 30 seconds. OK, so one doesn't jump from one processor to another often, but it's still a step back from the PICkit 2 where new firmware was only required during the installation of a new version of MPLAB.

The combination of a bi-colour status LED and a transparent plastic case has made the LEDs almost unreadable unless you are looking directly over the LED. Not that we paid much attention to the LED anyway!

Surprisingly, there is no support for the 'on-the-go' programming feature of the PICkit 2. This allowed you to program processors without the need for a PC, where the PIC program file is held in flash memory within the programmer and the programming sequence is initiated by pressing the button. All that is required is a 5V power supply connected to the PICkit 2's USB interface. Now this serves a fairly niche market (small companies with many boards to reprogram, for example), but the feature has been dropped from

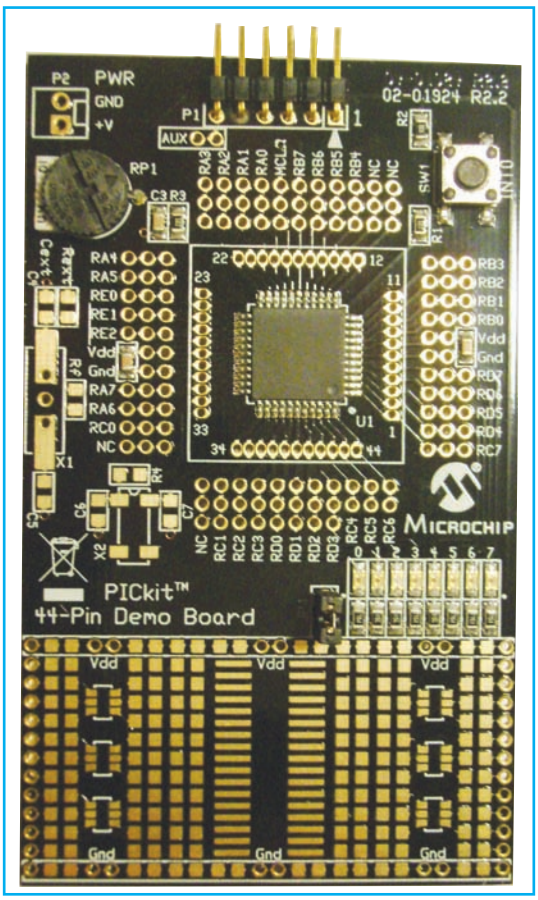


Fig.4. The demo board has been upgraded with a PIC18F45K20 processor

PICkit 3, resulting in a great deal of anger from otherwise loyal customers.

An even greater annoyance – certainly our greatest gripe – is the absence of the standalone programming application. We all have our own personal preferences for software development and debugging, and ours was to use our own favorite editor (Crimson Editor – a great free application by the way,) a command shell to compile the application, and the PICkit 2 programmer utility for programming. With all three programs open simultaneously it provided a very fast edit-compile-download-debug cycle.

With the programmer utility unavailable for the PICkit 3, we are *forced* to use MPLAB, a tool that does not suit everyone. Engineers are very particular about their use of tools, and Microchip made a rare but big mistake here. Fortunately, the feedback has been so intense that Microchip have admitted their mistakes and are working on software upgrades to resolve them.

Upgrading

The key reason for upgrading to a PICkit 3 is the far wider range of processors that it supports compared to the PICkit 2. The new, more powerful processors naturally place a much greater demand on any debugging hardware, and so it is not a surprise that PICkit 2 cannot support them. We feel the approach from Microchip will probably be to scale down support of the PICkit 2.

On the plus side, however, the more powerful processor in PICkit 3 should enable Microchip to start providing better debugging support for the more advanced peripherals. Historically, Microchip have been very good at providing additional features in their tools, so we will be watching the subsequent releases of MPLAB with interest.

Conclusions

The PICkit 3 is a good, reasonably priced device that has probably been designed with future proofing in mind. If you've never used a PICkit 2, you will like it. If you have used a PICkit 2, then hold off as long as possible before buying one. The *only* reason for purchasing one is for supporting new devices.

Like it or not, the PICkit 3 is the future of low-cost programming hardware from Microchip. As new devices are added to the product family they will find their way into the PICkit 3 only, and eventually PICkit 2 will no doubt be phased out.

It's a pity, and we will continue to use our PICkit 2 until it dies, and only bring the PICkit 3 into service when necessary. You are free, of course, to purchase a third-party programmer, and there are plenty available (Olimex being one good source), but if you are in the habit of using the latest processors from Microchip, then the PicKit3 will be a necessity.

Pricing is a little confusing at the moment. The reviewed kit, part number DV164131, can be purchased from RS components for £41, but the same part at Farnell is over £100. Farnell, however, stock just the PICkit 3 unit itself for just £28 – excellent value for what it is. The demo PCB is a nice feature if you are new to PIC microcontrollers, but certainly not essential, and you will be quickly making up your own circuits.

Overall, however, it's a reasonable device. Good value, and, we suspect, fairly future proof. ***EPE***

EPE EXCLUSIVE

Win a Microchip PICkit 3 Debug Express Kit!

Have you read the review and would like your own kit?

EVERYDAY PRACTICAL ELECTRONICS is offering its readers the chance to win one of four new MPLAB PICkit 3 Debug Express kits from Microchip. The PICkit 3 Debug Express allows debugging and programming of PIC and dsPIC Flash microcontrollers at a low price point, using the powerful graphical user interface of the MPLAB Integrated Development Environment (IDE).

The PICkit 3 Debug Express works with 8- and 16-bit PIC MCUs and dsPIC digital signal controllers (DSCs), and will support 32-bit PIC MCUs at a later date.

The PICkit 3 Debug Express kit includes:

- PICkit 3 debugger and programmer probe
- 44-pin demo board populated with a PIC18F45K20 MCU
- *Free* MPLAB IDE
- *Free* version of the MPLAB C Compiler for PIC18 MCUs.

All this is supported by easy-to-understand lessons and tutorials, and a host of other software utilities, examples with source code and full documentation.

HOW TO ENTER

For your chance to win a PICkit 3 Debug Express Kit, visit: **www.microchip-comps.com/epe-pickit3** and enter your details in the online entry form.

CLOSING DATE

The closing date for this offer is **31 August 2010**

WORTH $69.99 (approx. £50.00) EACH

Smart battery management

FREQUENT *EPE Chat Zone* contributor ***Alex*** posted the following question about 'smart' batteries on the forum (**www.chatzones.co.uk**).

You would expect a battery to need only two terminals, but laptop batteries come with several. So presumably they contain some 'smarts'. What are the extra terminals for? What is being monitored/controlled?

Modern personal electronic equipment, such as mobile phones, notebook computers, high-end digital cameras and video cameras often uses specialist battery packs, which, as Alex suggests, contain more than just the battery chemistry. The 'smart' electronics in the battery pack forms part of the battery management system of the product. There are a number of reasons why it is necessary to have battery management in these systems, and consequently a number of different functions are performed by the battery management system.

Power management

Power management is an important part of systems such as mobile phones and notebook computers. Users expect to be given a reasonably reliable indication of remaining battery life, and the system may use battery capacity data to optimise battery life via a power management system, or alter aspects of its behaviour under low battery conditions. Furthermore, some batteries may need to stop being discharged, even though they could supply more charge, in order to maximise battery life. The battery management system therefore needs to include accurate measurements of the remaining battery capacity; this is known as 'battery fuel gauging'.

Portable systems often use rechargeable batteries, which are recharged when the system is connected to an external power source (typically either a mains power supply or USB connection). The battery management system controls and monitors the charging process, attempting to provide optimal charging conditions to ensure maximum usage of the system for single charge, and maximise battery life over multiple charging cycles. The host system needs to respond correctly when the user connects and disconnects the external power source, particularly if the charger is built into the host system, rather than in an external charger device.

State-of-charge

Many portable systems use lithium-ion (Li-on) batteries which can explode or catch fire under certain conditions. Problems with battery safety have been reported in the mass media on a number of occasions, with the recall of laptop batteries by Sony in 2006 being perhaps the most well known case. For Li-ion battery packs, the battery management system needs to monitor battery operating conditions such as cell voltages, impedances, discharge currents and temperature to ensure that the battery is within its safe operating area. The battery protection system should detect potentially dangerous situations due to external or usage conditions (eg, external short circuits) or faults with the battery itself.

Another aspect of obtaining safe and effective operation for Li-ion batteries is ensuring that all cells in a multi-cell battery have the same state-of-charge (SOC) during both charging and discharging. This is known as cell balancing. Smart batteries may contain electronics which intelligently balances the SOC of the cells in the battery by switching in bypass paths for cells when required. Excessive cell imbalance can be used to help detect fault conditions in the battery.

Smart ID

Smart battery packs may contain a means of battery identification so that the system can check that the correct battery is connected, adapt to different battery options, or manage multiple individual batteries. This identifier may be simply using a resistor value or basic digital identification code. If security is a concern, then a more complex cryptographic authentication may be used, so that only batteries manufactured by the original system manufacturer, or others licensed by them, will be accepted by the system.

So called 'after market' batteries made by unauthorised third party manufactures may be popular with users because they are cheaper, but may perform poorly and/or reduce the profits which manufacturers can make from selling spare and replacement battery packs. Battery authentication can improve safety by ensuring that it is difficult to counterfeit branded battery packs designed for specific products. This is a real issue for manufactures. For example, in October 2004, Kyocera Wireless Corp. recalled a large number of potentially counterfeit mobile phone batteries due to safety concerns.

Part of the total battery management system will be contained within the battery pack itself. In particular, this is likely to include all or part of the authentication, protection and gauging circuits. Authentication circuitry must reside in the battery pack, but placement of gauging circuits may be in the host system or the pack. Putting more circuitry in the battery pack (making it 'smarter') may improve functionally and system performance, but will increase the

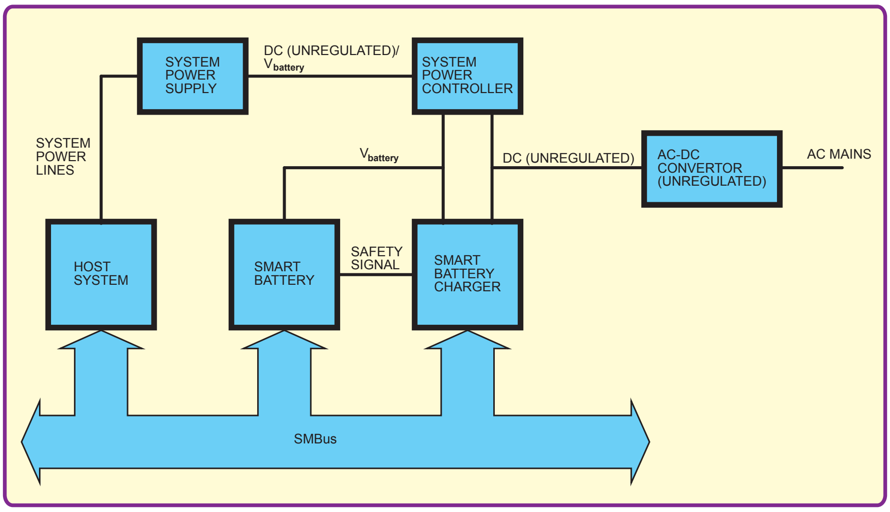


Fig.1. Typical structure of the power supply management for a system using the smart battery system (SBS) specification

cost and size of the battery pack, so each manufacturer will make design decisions and trade-offs based on their individual system and market requirements.

On the bus

A smart battery pack will need to communicate with the host system and this will usually be achieved using some form of serial bus, such as the 2-wire system management bus (SMBus) or I²C buses, or the single wire 1-Wire or HDQ buses. The SMBus is based on the I²C bus and is part of the smart battery system (SBS) specification/standard that is used by some smart battery packs.

The SBS specification defines interactions between a host system, smart battery charger and a smart battery pack using the SMBus. Fig.1 shows the structure of a typical system using the SBS specification. The SBS specification also provides means to manage systems, such as notebook computers, which use multiple batteries. Full details of the SBS standard can be found on the standard's web site at: **smartbattery.org**.

Special ICs

There are a large number of ICs available from semiconductor manufactures which provide the functions needed in smart battery packs and battery management systems. These include battery charger chips, battery authentication ICs, Li-ion protection circuits, gauging circuits and cell-balancing system. To illustrate the circuits that might be found in a smart battery pack, we will take a brief look at a few ICs designed for use in battery management.

The DS2740 from Maxim Integrated Products (**maxim-ic.com**) is a high-precision current-flow measurement and coulomb counter IC for battery fuel gauging. It can measure current bidirectionally with a range of 15 bits (DS2740U) or 13 bits (DS2740BU), with the net flow accumulated in a separate 16-bit register.

The DS2740 communicates with the host system using the 1-Wire serial bus protocol (designed by Dallas Semiconductor). Each chip has a unique factory-programmed 64-bit net address, so that multiple batteries/packs can be monitored using a single bus (with the host as the single bus master).

The DS2740 is mainly intended for use in the host system, but it is also suitable for inclusion in a battery pack. The advantage of including the gauge chip in the battery pack is that the measured capacity will remain accurate if batteries are swapped, or if they charged or discharged while not connected to the host system.

Fig.2 shows a typical DS2740 circuit configured for battery pack use. The DS2740 should be connected on the pack terminal side of any battery protector to prevent unwanted charge paths through the protector. The 150Ω resistor and 5.6V Zener diode at the serial communications interface, and the 150Ω resistor from the battery pack positive supply to the DS2740 V_{DD} supply pin provide electrostatic discharge (ESD) protection and protection from voltage transients. The PIO pin is not shown connected in Fig.2; it is a programmable I/O pin, controllable via the serial interface. The OVD pin is either tied to V_{SS} or V_{DD} to select the high-speed (overdrive) or standard versions of the 1-Wire bus.

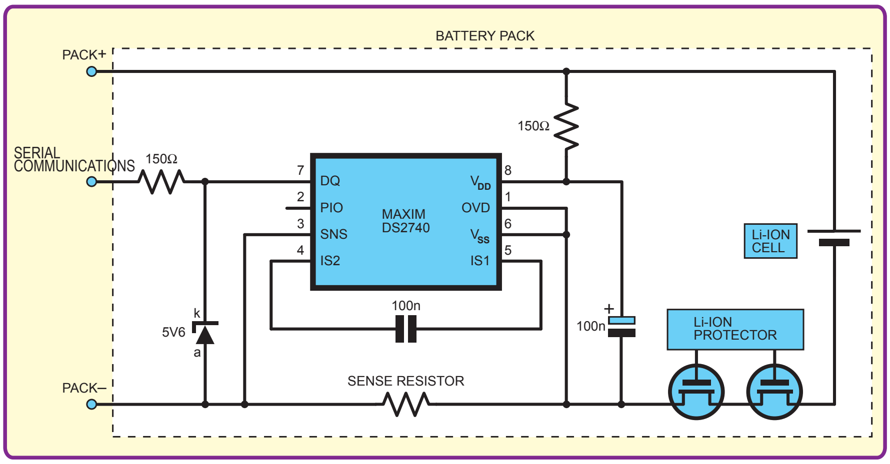


Fig.2. Typical Maxim DS2740 battery gauging circuit when located in a battery pack

The current is measured using a sense resistor in the negative supply line; this has a value of 5mΩ to 20mΩ, depending on the current measurement range required. The capacitor between the IS1 and IS2 pins, together with internal resistors, form a low-pass filter at the input of the DS2740's internal ADC. This extends the input range for pulse-type load currents.

Pack protection IC

The UCC3957 from Texas Instruments (**ti.com**) is a three or four cell Li-ion battery pack protector IC. A typical circuit for this chip is shown in Fig.3. A cell-count pin (CLCNT) is used to set the number of cells being protected. The circuit in Fig.3 is configured to protect a battery pack using a stack of three Li-ion cells.

The UCC3957 uses two external *P*-channel MOSFETs, TR1 and TR2, for the protection switches. This is similar to the protector shown in Fig.2, except that high-side (pack positive supply), rather than low-side (pack negative supply, or ground), switching is used.

If any cell voltage exceeds the overvoltage threshold, the appropriate MOSFET is turned off, preventing further charge current. The *N*-channel MOSFET, TR3, is used to level-shift the control signal from the chip to the high-side *P*-channel 'charge' MOSFET, TR1. When charging is blocked, discharge current can still be allowed to flow through the 'discharge' MOSFET, TR2.

Similarly, if any cell voltage falls below the under-voltage limit, both MOSFETs are turned off. This condition causes the chip to go into low-power sleep mode, but attempting to charge the battery pack wakes up the chip (detected by the WU pin). During the charging the MOSFETs are on, apart from short periods when the chip samples the cell voltages.

The UCC3957 also provides over-current protection, which allows the battery pack to provide short current surges to loads that require this, but provides short-circuit protection by switching off the discharge MOSFET if over-current occurs for longer than a preset time. Two current thresholds are used, with timing of the cut-off trigger

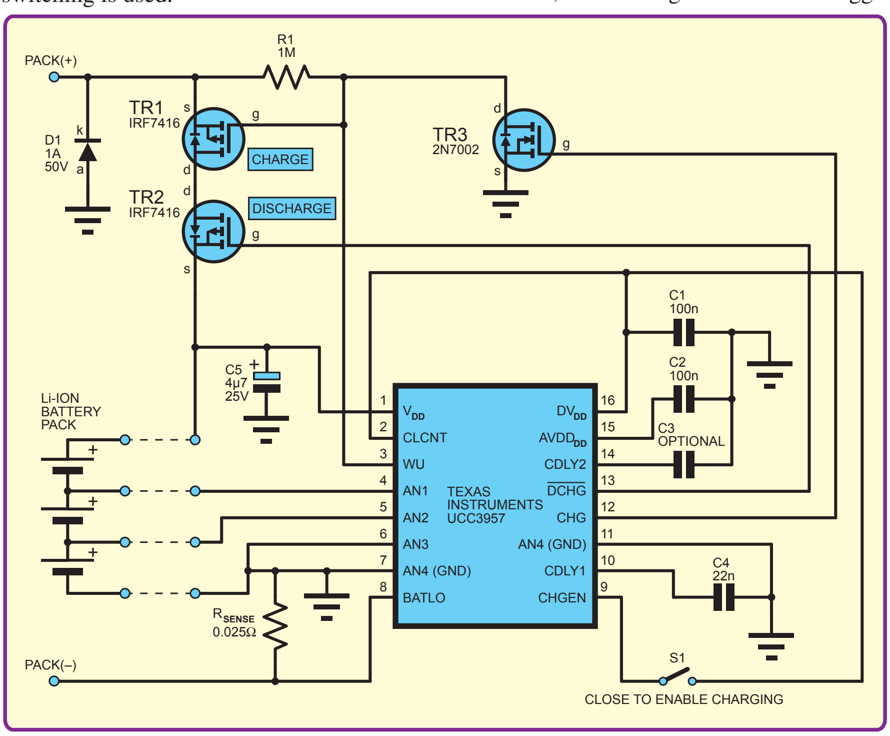


Fig.3. Typical Li-ion battery pack protection circuit using the UCC3957 from Texas Instruments

and off times determined in relation to the capacitor values connected to the CDLY1 and CDLY2 pins.

The chip is able to sense disconnection of the cell connections (AN1 to AN4) and responds as if the cells are overcharged, to prevent possible undetectable overcharging. D1 is used to protect the discharge FET from switching spikes, due to the inductance in the pack and external wiring. Capacitor C5 protects the IC from switching spikes due to the inductance of the cells and associated wiring.

One approach to cryptographic battery authentication is to use the Secure Hash Algorithm (SHA-1). This was designed by the National Security Agency, the cryptographic intelligence agency of the United States government. The pair of ICs DS2705 (master) and DS2703 from Maxim provide an implementation of this system.

In this approach, the host system (using the DS2705) issues a random 64-bit challenge to the battery pack, which responds (via the DS2703) with a 160-bit response. All bits of the response must match the expected result in the DS2705 for authentication to occur. Communication between the chips uses the 1-Wire bus previously mentioned in the context of the DS2740 gauging IC. The secret key used in the authentication is stored on chip, but never passed between host and battery pack, and so cannot be 'sniffed' by monitoring the bus.

The DS20703 provides the additional functionality of thermistor measurement. When the appropriate command is issued to it over the 1-Wire bus, it presents the thermistor impedance on the data line so that the host system can measure the battery pack temperature.

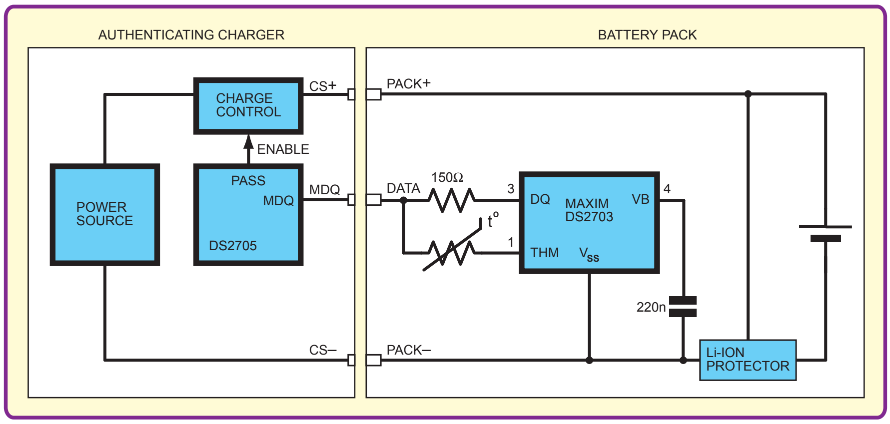


Fig.4. Example cryptographic battery authentication circuit using the DS2705 and DS2703 from Maxim

Authentication circuit

Fig.4 shows a simplified, typical authentication circuit using the DS2705 and DS2703 in which a battery charger authenticates the battery pack before enabling charger operation. The location of the thermistor in the DS2703 circuit is shown, although the circuitry to measure temperature is not included in the schematic.

In this article, we have only looked briefly at three battery management ICs. For details of these chips please consult the relevant datasheets on the manufacturers' websites. There are, of course, many more battery management ICs available from these and other manufacturers; however, these examples provide some insight into the 'smarts' in battery packs that Alex was asking about.

Datasheets

DS2703 http://datasheets.maxim-ic.com/en/ds/DS2703.pdf

DS2705 http://datasheets.maxim-ic.com/en/ds/DS2705.pdf

DS2740 http://datasheets.maxim-ic.com/en/ds/DS2740.pdf

UCC3957 http://focus.ti.com/lit/ds/symlink/ucc3957-1.pdf

INTERFACE

By Robert Penfold

USB PARALLEL OUTPUT INTERFACE

The previous two *Interface* articles covered the basics of using the FT232RL and FT245RL chips to provide an easy means of interfacing to a PC's USB port using a virtual RS232C serial port. These chips are primarily intended as a means of interfacing a USB port to a microcontroller, such as one of the PIC devices. The FT232RL provides a RS232C-type serial link to the controller, and the FT245RL uses an 8-bit bidirectional parallel bus.

As pointed out in the previous article, the parallel nature of the FT245RL means that it does not really need to be used in conjunction with a microcontroller when only a few input or output lines are required. This is a topic that will be pursued further in this article.

Grabbing a byte

The FT245RL effectively has a built-in UART (universal asynchronous receiver/transmitter). Unfortunately, unlike a conventional UART such as the old 6402, it does not have separate input and output ports. It has a bidirectional bus, and this has tri-state outputs that cannot provide latched bytes when the device is used to receive data. However, it is not difficult to use an external latch circuit to provide a basic 8-bit output port. A suitable circuit is shown in Fig.1.

The left-hand section of the circuit contains the FT245RL, and it derives the 8-bit bidirectional bus from a USB port. This was covered in the previous *Interface* article and will not be considered further here. The RXF output at pin 23 of the FT245RL (IC1) goes low when a byte of data is available, and this signal must be used to generate a pulse that stores the data in an 8-bit data latch. It must also generate a pulse that indicates to IC1 that the byte has been received and stored. IC1 then clears the RXF output and gets ready to deal with the next byte.

IC2 is a 74LS373 octal transparent latch, which is used here as the data latch. I used the 'LS' version of this device as this was the type that I had to hand, but the circuit should work properly using a CMOS version instead. The 74LS373 has tri-state outputs, but this capability is of no value in the present application. The output enable ($\overline{OE}$) input at pin 1 of IC2 is therefore connected to the 0V supply rail so that the Q outputs are permanently enabled. Data is latched by applying a low-high-low pulse to the latch enable (LE) input at pin 11 of IC2.

A CMOS 4047BE multivibrator (IC3) is used here as a negative edge-triggered monostable. It is triggered when the RXF output of IC1 goes low, and it then generates the latching pulse for IC2 at its Q output (pin 10). At the same time, a suitable pulse to clear IC1 for the next byte is produced at its $\overline{Q}$ output (pin 11).

The duration of the output pulse is controlled by a *C-R* network (C4 and R1), and the pulse length is approximately 2.48 *C-R* seconds. With the specified values, this equates to about 25 microseconds. The exact pulse length should not be critical, although a shorter pulse might be needed for effective operation at high baud rates. The specified values gave good results at 9600 and 19200 baud.

Listing 1

```
Public Class Form1

    Private Sub Form1_Load(ByVal
sender As System.Object, ByVal e As
System.EventArgs) Handles MyBase.
Load
        SerialPort1.Open()

        HScrollBar1.SmallChange = 1
        HScrollBar1.LargeChange = 1
        HScrollBar1.Minimum = 0
        HScrollBar1.Maximum = 127
        HScrollBar1.Value = 0

    End Sub

    Private Sub HScrollBar1_Scroll
(ByVal sender As System.Object,
ByVal e As System.Windows.
Forms.ScrollEventArgs) Handles
HScrollBar1.Scroll
      Dim ByteBuffer(0) As Byte
      SerialPort1.Write(Chr(HScrollBar1.
Value))
      Label1.Text = (HScrollBar1.Value)
        End Sub
End Class
```

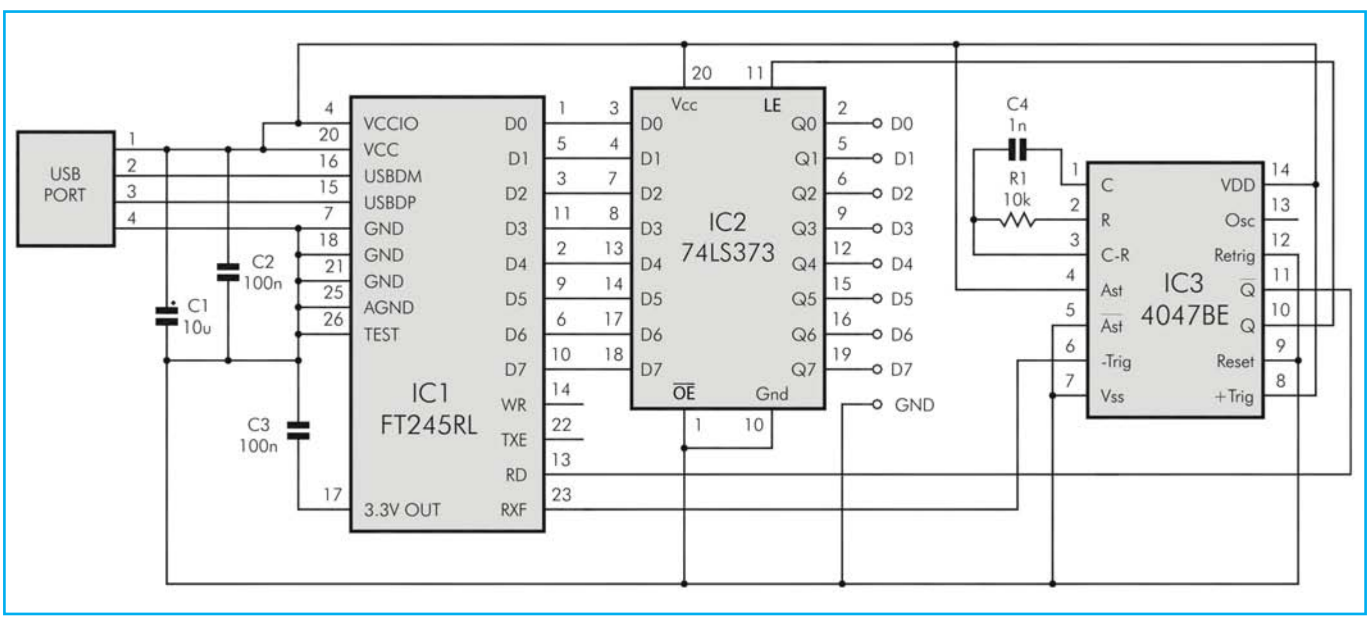


Fig.1. The circuit diagram for the USB parallel output interface. Data on the 8-bit bidirectional bus of IC1 is latched on the Q outputs of IC2 by the output pulses from IC3

Lacking drive

It is probable that the Windows Plug and Play facility will automatically install a suitable virtual serial port driver for the interface the first time it is used. If not, the necessary driver can be downloaded from the FTDI site at:

www.ftdichip.com/Drivers/VCP.htm

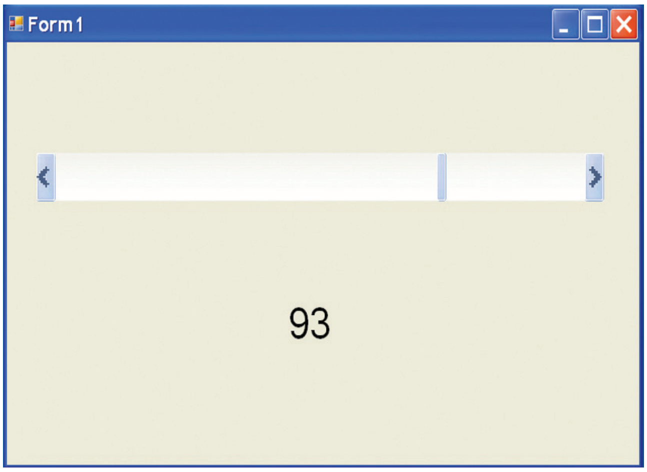


Fig.2. The demonstration program for the USB interface has a scrollbar that enables values from 0 to 127 to be output. Getting the most significant output of the interface to do anything useful seems to be problematic

Data can be written to the interface using Visual BASIC 2008 Express Edition and the method shown in Listing 1. This uses a horizontal scrollbar to generate values that are then written to the serial port. However, the values from the scrollbar have to be converted to corresponding ASCII characters first, since the Write instruction expects data to be in this form. A label component is used to display the current value of the scrollbar (Fig.2).

This program requires the form to have label, horizontal scrollbar, and serial port components added. The serial port must have the required baud rate set via its properties window, and the right COM port number must also be set here. The COM port number of unit's virtual serial port can be obtained by looking at the COM ports listed in Device Manager. The program sets suitable parameters for the horizontal scrollbar.

A bit missing

The serial port component provided with earlier versions of Visual BASIC (MSCOMM) had a limitation in that it only handled 7-bit values, even if it was set to use an 8-bit data format. Unfortunately, the serial port component of Visual BASIC 2008 seems to suffer from the same problem. Accordingly, the maximum value of the scrollbar has been set at 127 rather than 255, and output D7 is inoperative with this method of accessing the port.

There might be an easy way round this problem, but the suggested methods of writing bytes to the serial port that I found on the Internet failed to provide a solution. The missing bit is not a major limitation when interfacing to a microcontroller.

Data can be sent as ASCII digits, pairs of hexadecimal values, or something similar. A simple software routine in the microcontroller can then be used to reconstitute the original bytes of binary data. In fact, this method can be used to handle multiple bytes of data, 16-bit words, or just about anything else. This topic will be covered in a later *Interface* article.

Unfortunately, there is no easy way of implementing this type of thing using a simple interface based on two or three simple logic devices. Anyway, even as it stands, this interface provides a relatively simple way of obtaining seven output lines from a PC using a USB port. Seven outputs are more than adequate for many simple applications. With the days of user ports now long gone, and even parallel printer ports all but extinct, this probably represents the simplest method of controlling relays, motors, or whatever, using a modern computer.

Reduced resolution

A 7-bit resolution is also adequate for many applications where a DAC (digital-to-analogue converter) is being driven, since it provides zero plus 127 different levels of, for example, light intensity or motor speed. The circuit of Fig.3 is for a pulsed controller that provides a maximum output potential of about 12V, and can handle output currents of up to about 2A. It is based on a circuit featured in a previous *Interface* article, and the main difference here is that there is no need for a regulator circuit to provide a 5V supply for the AD557JN converter chip, IC1. It can be powered from the USB port's 5V supply instead.

The circuit requires a smoothed and regulated 15V supply that should be capable of providing a maximum current that is slightly higher than the highest load current that will be drawn from the controller. The power supply must provide current limiting, as there is no form of over-current protection built into the controller circuit.

Dissipation in the output transistor TR1 is relatively low due to the switching nature of the output stage. However, it still has to dissipate a few watts at high output currents, and a heatsink having a rating of about 10°C per watt or better is required. All four integrated circuits are MOS types, and hence require the usual anti-static handling precautions.

For 7-bit operation, the least significant input of the converter, which is bit 8 in the chip manufacturers terminology (pin 8 of IC1), is connected to ground (0V). The other seven inputs are then driven from D0 to D6 of the USB interface, with the defunct D7 being left unconnected. The alternative method of obtaining 7-bit operation is to connect bit 1 to ground and drive the other seven inputs from the interface, but this would roughly halve the maximum output voltage of the converter and give slightly reduced accuracy.

An output voltage range of 0V to 2.55V with 10mV resolution is normally obtained from the AD557JN, but with the suggested method of 7-bit operation this becomes 0V to 2.54V, with 20mV resolution. The signal processing stages provide a voltage gain of just less than five times, so the resolution at the output is a little under 100mV. In most applications this should be adequate to provide operation that is free from any obvious stepping as the output is taken from one level to the next.

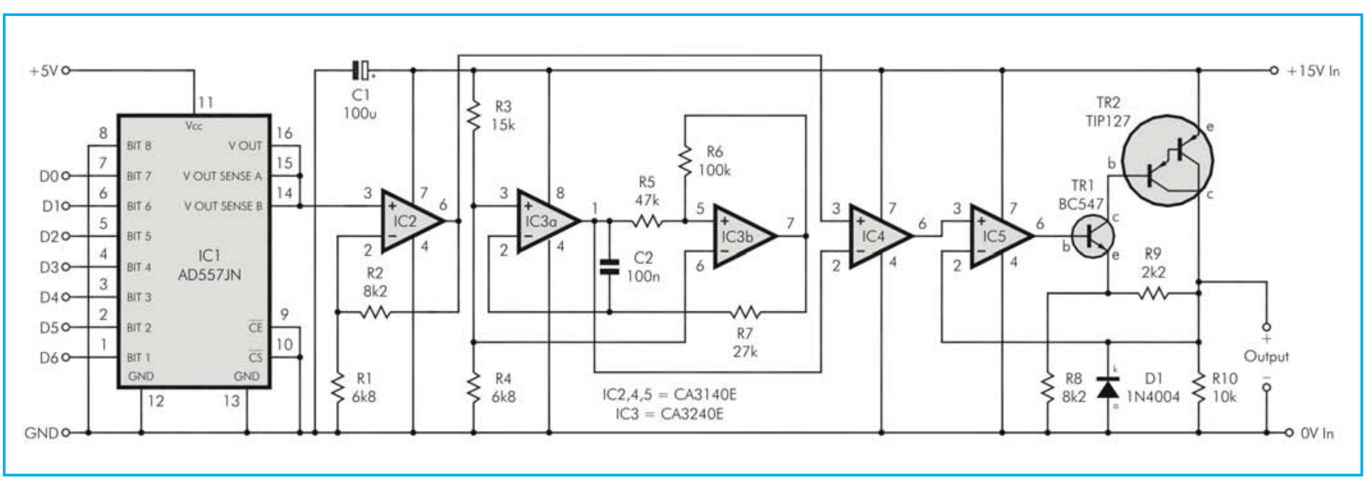


Fig.3. The circuit diagram for the pulse controller. A maximum output potential of about 12V can be provided, and the maximum output current is 2A

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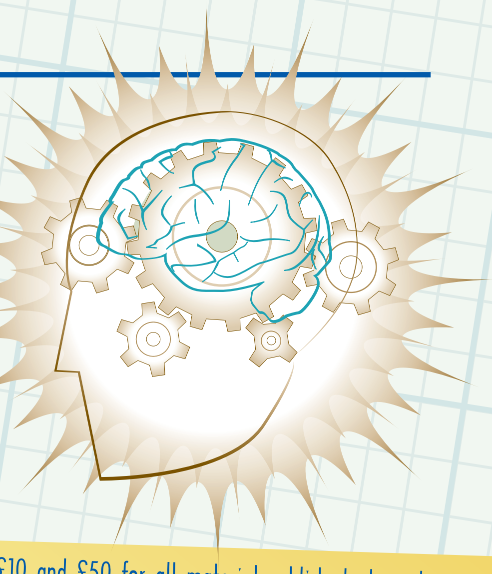

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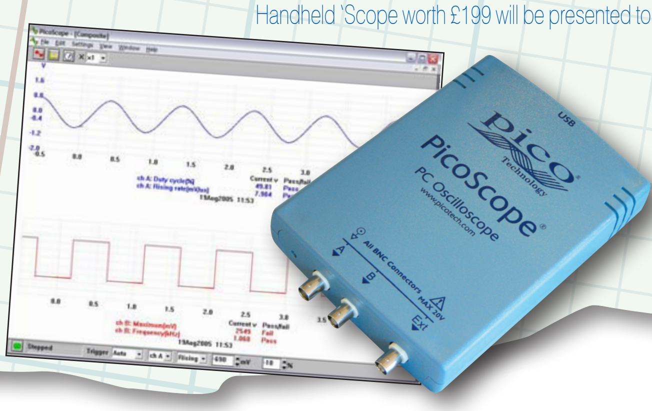

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Mobile Phone Battery Charger – *A hot line*

This project was necessitated by the fact that I occasionally forget to charge my mobile phone overnight and thus suffer the inconveinience of being without it for a number of hours during the following day.

What I needed was a spare mobile phone battery and a suitable charger so that I would always have a fully charged battery ready to insert into my mobile phone!

Today, its fairly easy to obtain a reasonably priced mobile phone battery via the internet, and in my case, I purchased a Sony Ericsson 750i battery for few pounds from eBay.

Charger considerations

The Sony Ericsson standard battery is a Li-Polymer type, with a nominal voltage of 3.6V and a capacity of 900mAh.

Charging lithium cells is fairly straightforward. You generate a well regulated voltage and ensure the charging current is sufficiently low so as not to cause overheating problems. Also, when the correct terminal voltage as been attained, it is important to shut down the charging process at that point.

In order to determine what the fully charged terminal voltage is, I removed the existing battery from the phone just after a charging

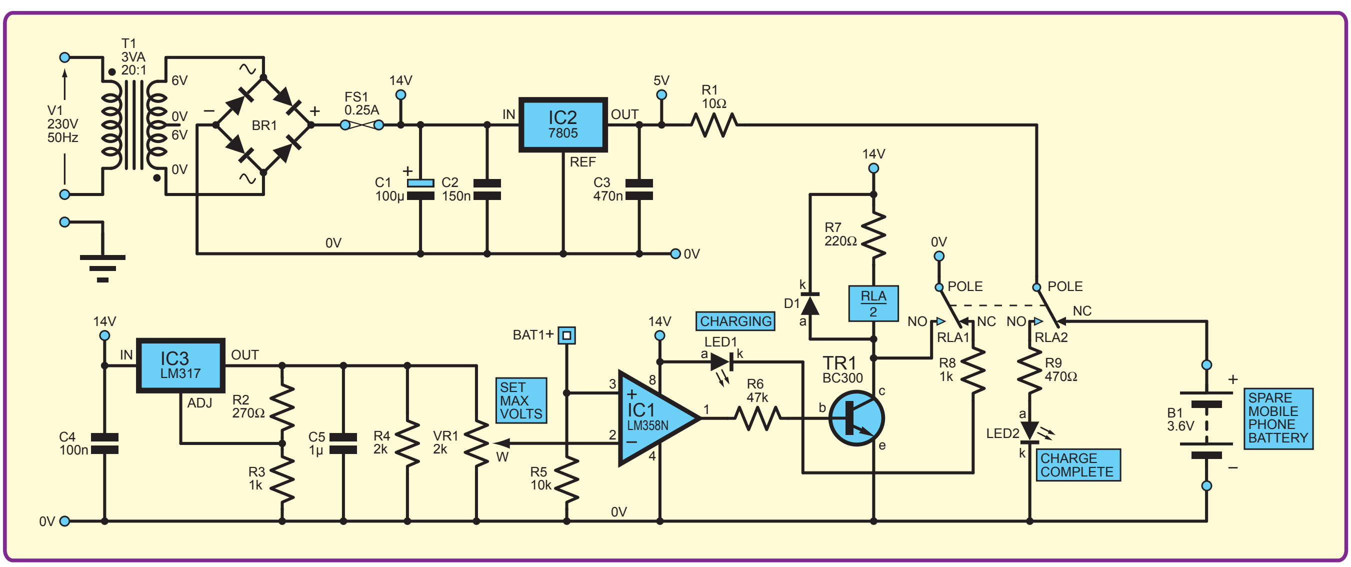


Fig.1. Complete circuit diagram for the Mobile Phone Battery Charger

session using the supplied charger, and found it to be an average of 4.15V open circuit. I also determined that somewhere in the range of 40mA to 70mA would be about right for the charging current. I then measured the terminal voltage of a depleted battery, and this turned out to be 3.1V

Armed with this basic design criteria, I then constructed the charger.

Circuit details

Fig.1 shows the complete circuit diagram for the Mobile Phone Charger. Many of the components have been sourced from the 'spares box', and so the design can vary somewhat depending on what parts are available.

The circuir consists of three main sections:

1) A 5V DC constant voltage supply, which serves as the charging source for the mobile phone battery. Mains voltage is transformed via T1, which is an RS 3VA unit, with the two 6V secondary windings connected in series. After rectification and smoothing, via BR1/C1, 14V DC is delivered to IC2, which is a 1A 5V regulator.

The regulator output delivers the charging current to the mobile phone battery via current limiting resistor R1 and via relay contacts RLA2. Fuse FS1 provides protection in the event of excess current flowing for whatever reason.

2) A 6V constant voltage reference source, which provides the 'setpoint' for the switched charge controller. A means of producing a reference voltage equal to the fully charged battery open circuit voltage is required. (4.15V in the case). This is achieved by utilising an LM317 device (IC3), which is an adjustable 3-terminal positive voltage regulator capable of supplying in excess of 100mA over an output voltage range of 1.25V to 37V.

This voltage regulator is exceptionally easy to use and requires only two external resistors to set the output voltage. Thus, resistors R2 and R3 set the LM317 output at 6V, and this potential is applied acrosss a 10-turn pot (VR1), the wiper (moving contact) picks off 4.15V and applies it to the inverting input of IC1. Note, the 4.15V was measured by a high impedance digital meter during setup.

3) A voltage comparator device, with an associated 12V relay switching and latching the circuit. Op amp IC1 is an LM358N, and is configured as a voltage comparator. The non-inverting input is connected directly to the +V ternminal of the mobile phone being charged via the 10kΩ resistor R5.

When a discharged battery is connected into the circuit, the non-inverting input of IC1 will be lower than the inverting input, and IC1 output will be at, or near to 0V. Transistor TR1 will be switched off and relay RLA will be de-energised. Under this condition, relay contacts RLA1 will permit energising of LED1 (charging), and relay contacts RLA2 will permit the charging current to flow from IC2 via R1 into battery B1.

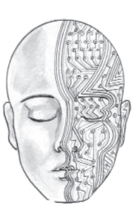
As the battery accumulates charge, eventually, the battery voltage will slighty exceed the setpoint voltage (4.15V) and the output of comparater IC1 immediately swings fully positive and switches TR1 on, which in turn energises relay RLA. Relay contacts RLA1 now latches the relay, thus ensuring that no over-charging can take place and contacts RLA2 energises LED2, the 'charge complete' indicator. The battery is then disconnected from the charger, which is reset by removing the mains supply ready for the next charging cycle.

Mobile battery holder

The Sony Ericsson battery lends itself to light clamping in a wooden block, with two pointed 6BA screws acting as terminal contacts; I then connect the 'holder' to the charger via leads with crocodile clips attached to the other ends of the screws.

The charger has been operating without problems for the past six months, and the mobile phone exhibits normal operation.

G. **Caldwell, N Ireland**



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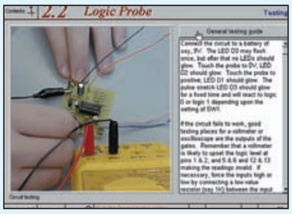

Logic Probe testing

Electronic Projects is split into two main sections: **Building Electronic Projects** contains comprehensive information about the components, tools and techniques used in developing projects from initial concept through to final circuit board production. Extensive use is made of video presentations showing soldering and construction techniques. The second section contains a set of ten projects for students to build, ranging from simple sensor circuits through to power amplifiers. A shareware version of Matrix's CADPACK **schematic capture, circuit simulation** and **p.c.b. design** software is included.
The projects on the CD-ROM are: Logic Probe; Light, Heat and Moisture Sensor; NE555 Timer; Egg Timer; Dice Machine; Bike Alarm; Stereo Mixer; Power Amplifier; Sound Activated Switch; Reaction Tester. Full parts lists, schematics and p.c.b. layouts are included on the CD-ROM.

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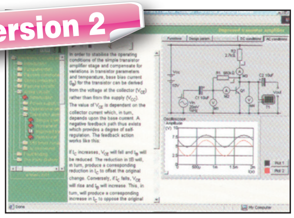
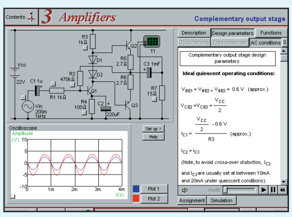


Circuit simulation screen

Electronics Circuits & Components V2.0 provides an introduction to the principles and application of the most common types of electronic components and shows how they are used to form complete circuits. The virtual laboratories, worked examples and pre-designed circuits allow students to learn, experiment and check their understanding. Version 2 has been considerably expanded in almost every area following a review of major syllabuses (GCSE, GNVQ, A level and HNC). It also contains both European and American circuit symbols. Sections include: ***Fundamentals***: units and multiples, electricity, electric circuits, alternating circuits. ***Passive Components***: resistors, capacitors, inductors, transformers. ***Semiconductors***: diodes, transistors, op amps, logic gates. ***Passive Circuits. Active Circuits***. *The Parts Gallery* will help students to recognise common electronic components and their corresponding symbols in circuit diagrams.
Included in the Institutional Versions are multiple choice questions, exam style questions, fault finding virtual laboratories and investigations/worksheets.

ANALOGUE ELECTRONICS

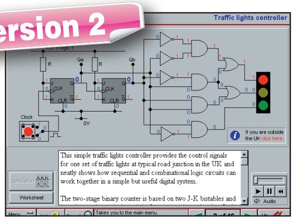


Complimentary output stage

Analogue Electronics is a complete learning resource for this most difficult branch of electronics. The CD-ROM includes a host of virtual laboratories, animations, diagrams, photographs and text as well as a SPICE electronic circuit simulator with over 50 pre-designed circuits.
Sections on the CD-ROM include: ***Fundamentals*** – Analogue Signals (5 sections),Transistors (4 sections), Waveshaping Circuits (6 sections). ***Op Amps*** – 17 sections covering everything from Symbols and Signal Connections to Differentiators. ***Amplifiers*** – Single Stage Amplifiers (8 sections), Multi-stage Amplifiers (3 sections). ***Filters*** – Passive Filters (10 sections), Phase Shifting Networks (4 sections), Active Filters (6 sections). ***Oscillators*** – 6 sections from Positive Feedback to Crystal Oscillators. ***Systems*** – 12 sections from Audio Pre-Amplifiers to 8-Bit ADC plus a gallery showing representative p.c.b. photos.

DIGITAL ELECTRONICS V2.0

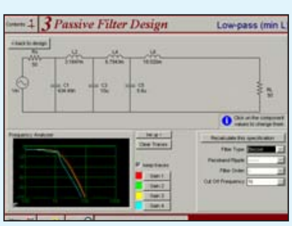
Version 2



Virtual laboratory - Traffic Lights

Digital Electronics builds on the knowledge of logic gates covered in *Electronic Circuits & Components* (above), and takes users through the subject of digital electronics up to the operation and architecture of microprocessors. The virtual laboratories allow users to operate many circuits on screen.
Covers binary and hexadecimal numbering systems, ASCII, basic logic gates, monostable action and circuits, and bistables – including JK and D-type flip-flops. Multiple gate circuits, equivalent logic functions and specialised logic functions. Introduces sequential logic including clocks and clock circuitry, counters, binary coded decimal and shift registers. A/D and D/A converters, traffic light controllers, memories and microprocessors – architecture, bus systems and their arithmetic logic units. Sections on Boolean Logic and Venn diagrams, displays and chip types have been expanded in Version 2 and new sections include shift registers, digital fault finding, programmable logic controllers, and microcontrollers and microprocessors. The Institutional versions now also include several types of assessment for supervisors, including worksheets, multiple choice tests, fault finding exercises and examination questions.

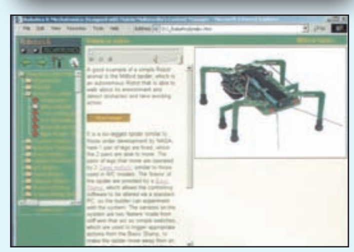
ANALOGUE FILTERS



Filter synthesis

Analogue Filters is a complete course in designing active and passive filters that makes use of highly interactive virtual laboratories and simulations to explain how filters are designed. It is split into five chapters: **Revision** which provides underpinning knowledge required for those who need to design filters. **Filter Basics** which is a course in terminology and filter characterization, important classes of filter, filter order, filter impedance and impedance matching, and effects of different filter types. **Advanced Theory** which covers the use of filter tables, mathematics behind filter design, and an explanation of the design of active filters. **Passive Filter Design** which includes an expert system and filter synthesis tool for the design of low-pass, high-pass, band-pass, and band-stop Bessel, Butterworth and Chebyshev ladder filters. **Active Filter Design** which includes an expert system and filter synthesis tool for the design of low-pass, high-pass, band-pass, and band-stop Bessel, Butterworth and Chebyshev op.amp filters.

ROBOTICS & MECHATRONICS



Case study of the Milford Instruments Spider

Robotics and Mechatronics is designed to enable hobbyists/students with little previous experience of electronics to design and build electromechanical systems. The CD-ROM deals with all aspects of robotics from the control systems used, the transducers available, motors/actuators and the circuits to drive them. Case study material (including the NASA Mars Rover, the Milford Spider and the Furby) is used to show how practical robotic systems are designed. The result is a highly stimulating resource that will make learning, and building robotics and mechatronic systems easier. The Institutional versions have additional worksheets and multiple choice questions.

- Interactive Virtual Laboratories
- Little previous knowledge required
- Mathematics is kept to a minimum and all calculations are explained
- Clear circuit simulations

PRICES

Prices for each of the CD-ROMs above are:

(Order form on third page)

Hobbyist/Student	**£45**	**inc VAT**
Institutional (Schools/HE/FE/Industry)	**£99**	**plus VAT**
Institutional 10 user (Network Licence)	**£249**	**plus VAT**
Site licence	**£499**	**plus VAT**

(UK and EU customers add VAT at 17.5% to 'plus VAT' prices)

PICmicro TUTORIALS AND PROGRAMMING

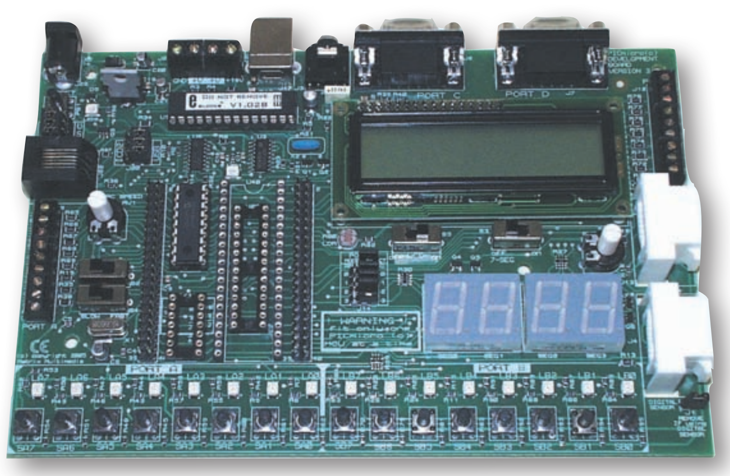
HARDWARE

VERSION 3 PICmicro MCU development board

Suitable for use with the three software packages listed below.

This flexible development board allows students to learn both how to program PICmicro microcontrollers as well as program a range of 8, 18, 28 and 40-pin devices from the 12, 16 and 18 series PICmicro ranges. For experienced programmers all programming software is included in the PPP utility that comes with the development board. For those who want to learn, choose one or all of the packages below to use with the Development Board.

- Makes it easier to develop PICmicro projects
- Supports low cost Flash-programmable PICmicro devices
- Fully featured integrated displays – 16 individual LEDs, quad 7-segment display and alphanumeric LCD display
- Supports PICmicro microcontrollers with A/D converters
- Fully protected expansion bus for project work
- USB programmable
- Can be powered by USB (no power supply required)



£158 including VAT and postage, supplied with USB cable and programming software

SOFTWARE

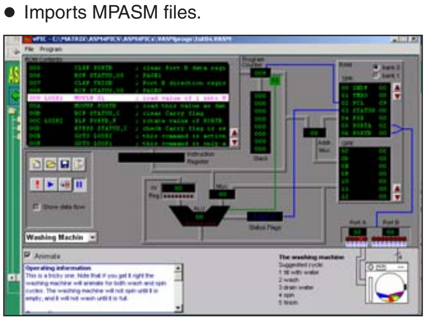
ASSEMBLY FOR PICmicro V3

(Formerly PICtutor)

Assembly for PICmicro microcontrollers V3.0 (previously known as PICtutor) by John Becker contains a complete course in programming the PIC16F84 PICmicro microcontroller from Arizona Microchip. It starts with fundamental concepts and extends up to complex programs including watchdog timers, interrupts and sleep modes.

The CD makes use of the latest simulation techniques which provide a superb tool for learning: the Virtual PICmicro microcontroller, this is a simulation tool that allows users to write and execute MPASM assembler code for the PIC16F84 microcontroller on-screen. Using this you can actually see what happens inside the PICmicro MCU as each instruction is executed, which enhances understanding.

● Comprehensive instruction through 45 tutorial sections ● Includes Vlab, a Virtual PICmicro microcontroller: a fully functioning simulator ● Tests, exercises and projects covering a wide range of PICmicro MCU applications ● Includes MPLAB assembler ● Visual representation of a PICmicro showing architecture and functions ● Expert system for code entry helps first time users ● Shows data flow and fetch execute cycle and has challenges (washing machine, lift, crossroads etc.) ● Imports MPASM files.

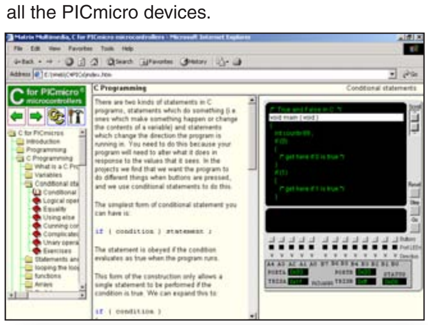


'C' FOR 16 Series PICmicro Version 4

The C for PICmicro microcontrollers CD-ROM is designed for students and professionals who need to learn how to program embedded microcontrollers in C. The CD-ROM contains a course as well as all the software tools needed to create Hex code for a wide range of PICmicro devices – including a full C compiler for a wide range of PICmicro devices.

Although the course focuses on the use of the PICmicro microcontrollers, this CD-ROM will provide a good grounding in C programming for any microcontroller.

● Complete course in C as well as C programming for PICmicro microcontrollers ● Highly interactive course ● Virtual C PICmicro improves understanding ● Includes a C compiler for a wide range of PICmicro devices ● Includes full Integrated Development Environment ● Includes MPLAB software ● Compatible with most PICmicro programmers ● Includes a compiler for all the PICmicro devices.



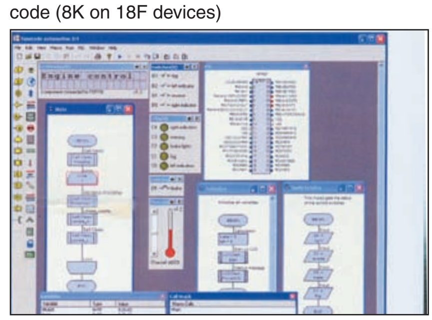
Minimum system requirements for these items: Pentium PC running, 2000, ME, XP; CD-ROM drive; 64MB RAM; 10MB hard disk space.
Flowcode will run on XP or later operating systems

FLOWCODE FOR PICmicro V4

Flowcode is a very high level language programming system based on flowcharts. Flowcode allows you to design and simulate complex systems in a matter of minutes. A powerful language that uses macros to facilitate the control of devices like 7-segment displays, motor controllers and LCDs. The use of macros allows you to control these devices without getting bogged down in understanding the programming. When used in conjunction with the Version 3 development board this provides a seamless solution that allows you to program chips in minutes.

- Requires no programming experience
- Allows complex PICmicro applications to be designed quickly
- Uses international standard flow chart symbols
- Full on-screen simulation allows debugging and speeds up the development process.
- Facilitates learning via a full suite of demonstration tutorials
- Produces ASM code for a range of 18, 28 and 40-pin devices
- 16-bit arithmetic strings and string manipulation
- Pulse width modulation
- I2C.

New features of Version 4 include panel creator, in circuit debug, virtual networks, C code customisation, floating point and new components. The Hobbyist/Student version is limited to 4K of code (8K on 18F devices)



PRICES

Prices for each of the CD-ROMs above are:

(Order form on next page)

Hobbyist/Student	**£45**	**inc VAT**
Institutional (Schools/HE/FE/Industry)	**£99**	**plus VAT**
Institutional/Professional 10 user (Network Licence)	**£350**	**plus VAT**
Site Licence	**£699**	**plus VAT**
Flowcode Institutional (Schools/HE/FE/Industry)	**£149**	**plus VAT**
Flowcode 10 user (Network Licence)	**£399**	**plus VAT**
Flowcode Site Licence	**£799**	**plus VAT**

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SPECIAL PACKAGE OFFER

TINA Pro V7 (Basic) + Flowcode V3 (Hobbyist/Student)

TINA Analogue, Digital, Symbolic, RF, MCU and Mixed-Mode Circuit Simulation, Testing and PCB Design

£68.00 inc. VAT and p&p

TINA Design Suite is a powerful yet affordable software package for analysing, designing and real time testing analogue, digital, MCU, and mixed electronic circuits and their PCB layouts. You can also analyse RF, communication, optoelectronic circuits, test and debug microcontroller applications.

Enter any circuit (up to 100 nodes) within minutes with TINA's easy-to-use schematic editor. Enhance your schematics by adding text and graphics. Choose components from the large library containing more than 10,000 manufacturer models. Analyse your circuit through more than 20 different analysis modes or with 10 high tech virtual instruments. Present your results in TINA's sophisticated diagram windows, on virtual instruments, or in the live interactive mode where you can even edit your circuit during operation.

Customise presentations using TINA's advanced drawing tools to control text, fonts, axes, line width, colour and layout. You can create, and print documents directly inside TINA or cut and paste your results into your favourite word- procesing or DTP package.

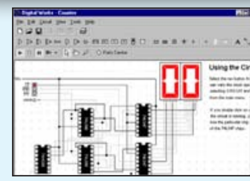
TINA includes the following Virtual Instruments: Oscilloscope, Function Generator, Multimeter, Signal Analyser/Bode Plotter, Network Analyser, Spectrum Analyser, Logic Analyser, Digital Signal Generator, XY Recorder.

Flowcode V3 *(Hobbyist/Student) – For details on Flowcode, see the previous page.*

This offer gives you two seperate CD-ROMs – the software will need registering (FREE) with Designsoft (TINA) and Matrix Multimedia (Flowcode), details are given within the packages.

Get TINA + Flowcode for a total of just £68, including VAT and postage.

DIGITAL WORKS 3.0



Counter project

Digital Works Version 3.0 is a graphical design tool that enables you to construct digital logic circuits and analyze their behaviour. It is so simple to use that it will take you less than 10 minutes to make your first digital design. It is so powerful that you will never outgrow its capability ● Software for simulating digital logic circuits ● Create your own macros – highly scalable ● Create your own circuits, components, and i.c.s ● Easy-to-use digital interface ● Animation brings circuits to life ● Vast library of logic macros and 74 series i.c.s with data sheets ● Powerful tool for designing and learning.

Hobbyist/Student £45 inc. VAT.
Institutional £99 plus VAT.
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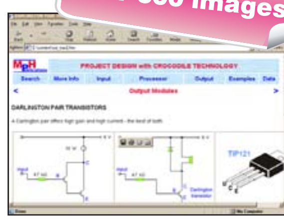
Nearly all the circuits can be instantly simulated in Crocodile Technology (not included on the CD-ROM) and you can customise the designs as required.*



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All circuits can be viewed, but can only be simulated if your computer has Crocodile Technoloy version 410 or later. A free trial version of Crocodile Technology can be downloaded from:* ***www.crocodile-clips.com**. Animated diagrams run without Crocodile Technology.*

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ELECTRONIC COMPONENTS PHOTOS

A high quality selection of over 200 jpg images of electronic components. This selection of high resolution photos can be used to enhance projects and presentations or to help with training and educational material. They are royalty free for use in commercial or personal printed projects, and can also be used royalty free in books, catalogues, magazine articles as well as worldwide web pages (subject to restrictions – see licence for full details).
Now contains Irfan View image software for Windows, with quick-start notes included.

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Minimum system requirements for these CD-ROMs: Pentium PC, CD-ROM drive, 32MB RAM, 10MB hard disk space. Windows 2000/ME/XP, mouse, sound card, web browser.

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- ☐ Assembly for PICmicro V3
- ☐ 'C' for 16 Series PICmicro V4
- ☐ Flowcode V4 for PICmicro
- ☐ Digital Works 3.0

Version required:
- ☐ Hobbyist/Student
- ☐ Institutional
- ☐ Institutional/Professional 10 user
- ☐ Site licence

Note: The software on each version is the same, only the licence for use varies.

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Max's Cool Beans

By Max The Magnificent

The Web is awash with 'Stuff'!

I tell you, there's so much cool stuff out there on the Internet that I'm surprised I actually manage to get any real work done. For example, I just ran across the Internet *Craftsmanship Museum* website at **www.CraftsmanshipMuseum.com**. I have to say that I love real craftsmanship, especially when it comes to mechanical engineering. There's something about a cunningly crafted 'thing' that makes me go 'Ooooh' and 'Ahhhh' ... which is exactly what you will say if you visit this site. Truth to tell, the site itself is very 'homemade', if you know what I mean, but the items you will discover there will take your breath away.

In fact, there's a whole bunch of stuff to see, from model engines, cars, planes, boats... to guns, clocks, and fine engraving. The site is organised (or rather disorganised) in such a way that you can spend hours meandering your way around trying to relocate something you saw only a few minutes before. But it's all time well-spent, and you'll be 'Ooooh-ing' and 'Ahhhh-ing' to yourself all the way. It may even start you thinking about something you've been planning on building yourself.

Roll-up computer

Of course, the big buzz at the moment is surrounding the recent launch of Apple's iPad. There was an interesting article on this by Stephen Fry in the 12 April issue of *Time Magazine*. Stephen got to hang out with the folks at Apple, and even got to spend an hour with Steve Jobs himself. He also got to play with a pre-release version of the iPad, and purchased his own as soon as it was possible to do so. The article concludes with Stephen (Fry, not Jobs) saying: "But for me, my iPad is like a gun lobbyist's rifle: the only way you will take it from me is to pry it from my cold, dead hands."

So I think it's safe to assume that Stephen likes the iPad, and we all know that it does indeed look amazingly cool, but I was a little surprised to discover that it cannot multitask. This means that you can either be browsing the Internet or creating a text document, for example, but you can't be doing both at the same time. This means that it wouldn't work for me, because I spend a huge amount of time meandering my way around the Internet researching 'stuff' and copying notes and quotes from web pages into my word processor. So, I think I'll wait for a future generation before I buy.

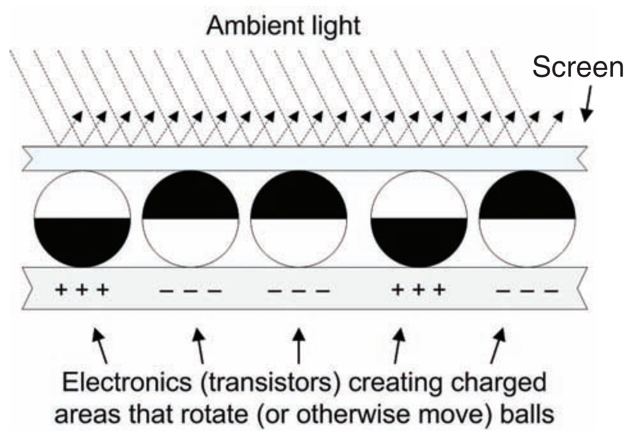
Speaking of which, have you seen that awesome video of a roll-up computer on YouTube (**www.youtube.com/watch?v=7H0K1k54t6A**). Apparently, this conceptual design was created as some student's thesis project. The result is incredible. The idea is a computer that looks to be about 3/8in. thick can roll up into a tube about 15in. long and 4in. in diameter. When unrolled, you get a screen/interface about twice the size of the iPad. The concept is based on the use of flexible organic light emitting diode (OLED) display technology. We aren't quite there yet, but this sort of computer might come sooner than you think!

Electronic paper

Electronic paper, or e-paper – also known as an 'electronic ink display' – is an electronic display technology that is designed to mimic the apperance of ordinary ink on paper. The first version of electronic paper was developed in the 1970s by Nick Sheridon at Xerox's Palo Alto Research Center. Since that time, a variety of different technologies have appeared (and sometimes disappeared again).

The way I tend to visulise how this works – and the way I explain it to my mother – is as shown below (the reason I'm being a little coy here is that the real stuff doesn't actually work this way, but if I tried to explain the gruesome details we'd be here all day. If you really want to know more, check out the electronic paper entry on the Wikipedia site at: **http://en.wikipedia.org/wiki/Electronic_paper**).

The idea is that we have two very thin flat sheets with a tiny gap between them. The upper flat sheet is transparent – this is the display surface that is presented to the outside world. Between the two sheets are untold millions of tiny balls, each around a micron in diameter (that's one millionth of a metre or one thousandth of a millimetre).



Each of these balls is half black and half white. By applying appropiate electric fields, each ball can be individually orientated so that it presents its black or white face to the outside world. Once the orientations of the balls have been set, they will remain in position without requiring any additional power until a new orientation is required.

Unlike the liquid crystal displays (LCDs) we're use to seeing on things like our cellphones, electronic paper does not require a backlight. Instead, ambient light is reflected off the surface of the display. This has two important implications. First, it means the display consumes no power once the balls have been orientated. Second, it means that the display doesn't 'washout' in bright light – it acts like a typical piece of white paper with black ink – the brighter the external light, the better it looks.

Check out 'The Cool Beans Blog' at www.epemag.com

Catch up with Max and his up-to-date topical discussions

READOUT

Email: editorial@wimborne.co.uk

Matt Pulzer addresses some of the general points readers have raised. Have you anything interesting to say? Drop us a line!

All letters quoted here have previously been replied to directly

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An Atlas LCR Passive Component Analyser, kindly donated by Peak Electronic Design Ltd, will be awarded to the author of the Letter Of The Month. The Atlas LCR automatically measures inductance from 1mH to 10H, capacitance from 1pF to 10,000µF and resistance from 1Ω to 2MΩ with a basic accuracy of 1%. www.peakelec.co.uk

☆ LETTER OF THE MONTH ☆

Cool uses for recycled heatsinks

Dear Editor

I am a big fan of recycling, which is why I have so many ideas. Although many might already be aware of them, others may not, so I hope you don't mind me writing in with a few of them.

I am talking 'heatsinks'. A heatsink is one of those things that when you need one, you really need one, and usually the only way to get one is to buy an off-the-shelf model, or make it yourself. Electronics enthusiasts like myself, who are into making audio amplifiers and power supplies are well aware of the sometimes heavy heatsinking requirements.

Since many of us don't have metal folding equipment and the other tools needed to make a decent heatsink, we are forced to buy one, sometimes at great expense, especially for some of the larger or more intricate types. However, a lot of the time you need look no further than the nearest computer repair shop. I run such an establishment (**www.pcanytime.co.nz**) and over the years have accumulated such a huge number of heatsinks, in all shapes and sizes, that I have ended up (I know, I know) throwing some of the smaller, less-likely-to-be-used ones away.

Fortunately, a cheap-as-chips (no pun intended) alternative is at hand. A few years ago, Intel Pentium 4 CPUs and large AMD Athlons were all the rage, and many manufacturers used some seriously heavy-duty fans and heatsinks to keep them cool. Dell, in particular, used beautiful, large-finned aluminium heatsinks that are ideal for inverters, power supplies and audio amplifiers.

It all depends on the people who run the repair shop. If, like me, they see value in keeping parts that may be used again one day, or just can't bear to throw something so useful out, you should be in luck (though I know of some places that simply chuck everything in the bin). It doesn't hurt to ask, and most repair workshops will, I think, have a good selection to choose from. Whether you want a small heatsink for a single TO-220, or a large one that can accommodate four or five TO-220-type devices, or three TO-3s, your local computer repair place could be a goldmine of parts.

All that most of these heatsinks need is a little drilling (and possibly tapping if one didn't want to use through-and-through fasteners) and then they are ready for use. As an added bonus, if you need a cooling fan, it can be easily added to most of them because the mounting brackets can be simply clipped on. Don't forget to ask if the fans are available too, as these are expensive and most CPU fans are of excellent quality and will have a lot of life left in them.

There are many other heatsinks in a computer you can salvage, often clipped onto Northbridge/Southbridge chipsets, and there are usually several heavy upright aluminium types in the power supply unit.

Most computer repair places would happily pass on these items to you at little-or-no cost because they would otherwise be stuck with getting rid of them. I'm not sure about the UK and Europe, but many recycling plants that previously accepted even dead hardware are now charging for disposal. This means it would be a godsend if someone came into my shop tomorrow and asked if I could spare some old CPU fan/heatsink assemblies, or maybe an old power supply or two!

Dave Thompson,
Christchurch, New Zealand

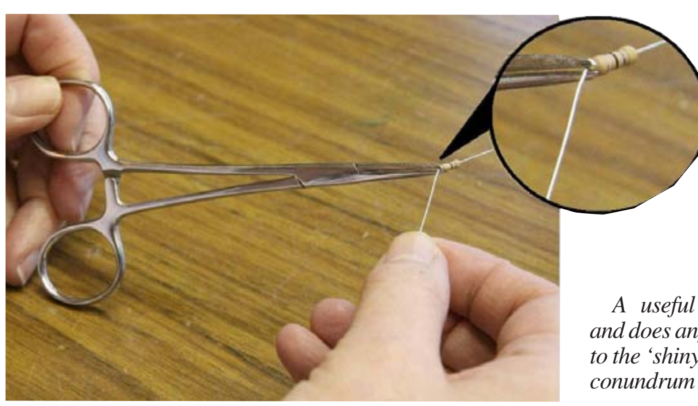
Thanks Dave – a top tip; I hope you keep on supplying your excellent ideas for recycling.

Handling delicate components

Dear Editor

In the March 2010 *Practically Speaking*, Robert Penfold draws attention to the delicacy of some components and the importance of bending their leads carefully. They can be bent successfully using the fingernail or screwdriver blade technique he suggests. However, for really fragile parts, I like the method illustrated in the accompanying photograph. It applies no force at all on the component's body-to-lead junction. The photo shows Chris, 'my t'other half', holding self-locking forceps in her fingers – fine needle-nose pliers are a viable alternative.

On a separate matter, I've become wary of those shiny plastic anti-static bags, as shown in Fig.2 of Robert's article. I find that the thick black rubbery sort of bag will conduct, as measured on the kilohm range of any multimeter. The same goes for conductive foam. However, in my experience, the shiny plastic ones seem to be perfect insulators – even at 500V from my 'Megger' insulation safety-tester!



Can anyone verify how these bags protect static-sensitive components?

Godfrey Manning,
Edgware, by email

A useful suggestion Godfrey, and does anyone know the answer to the 'shiny plastic bag insulator' conundrum?

Net Work

Alan Winstanley

A virtual treasure trove

In last month's *Net Work*, I highlighted the 'soft launch' in March of an expanded Google Street View, which offers a motorist's-eye panoramic view of almost all our streets and country lanes – 238,000 miles of them. The jury is out regarding the wisdom of laying bare every square inch of Britain this way, and Google's declared policy is to shrug and say that it's displaying nothing that an ordinary member of the public cannot see for themselves by wandering down the street.

The recriminations are already starting. Last month, a British householder in Bradford, Yorkshire criticised Google Street View because it snapped him standing in front of his house, next to his garage. The garage door was wide open and a valuable mountain bike was in clear view. The owner connects the bike's appearance on Street View with its subsequent theft, and there were further attempts to break into the garage afterwards.

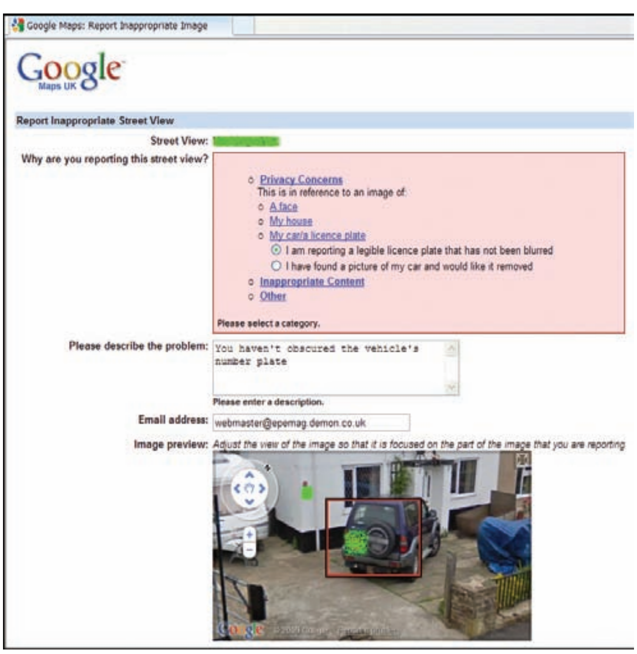
It's likely that some Internet-enabled, but otherwise unsophisticated elements of our gene pool will use Google Street View to scout around locally in search of rich pickings. As an example of how easy Google Street View brings to our computer screens a rich panorama of potential plunder, I opened Google Maps and dropped the yellow 'Pegman' totally at random somewhere on the UK, and then I switched to Street View. The first thing I saw was a well-tended suburban house with a 4x4 parked in front (with tow-bar, and its number plate perfectly visible), a caravan in the driveway ready to be driven away, an open gate and… an open garage (full of junk). A tarpaulin covers something interesting-looking in the front yard. All of this is potentially an open invitation to caravan thieves, as well as local enterprising burglars.

Assuming that the house's residents don't read *EPE*, my tightly-cropped screenshot demonstrates that they have what Google might term a 'Privacy Concern'. Google offers the 'Report A Problem' link, but only some restricted and carefully-worded options are available. You also have to pan a small window around the image in order to select the offending area.

Privacy concerns are categorised by Google in a very limited selection of choices: 'A Face' – any image of a face that has not been blurred, or 'My face' – I found a picture of my face (or my child's) which I would like to be blurred.

The next option is to report housing: 'My House' – I have found a picture of my house and would like it removed. So no digital nuking of your neighbour's property.

Finally, under Privacy Concerns is 'My car/a licence plate': you can report any legible licence plate number for blurring, or you can request that an image of your own car is removed. So I thought I'd do the above caravan owner a favour and report his 4x4 license plate as a 'Problem'.



Google Street View – anyone can 'Report A Problem' of an unblurred face or a visible licence plate, but all other aspects are left to the individual affected to complain

Separately, you can report inappropriate imagery (eg gross invasion of personal privacy) or security concerns (military, commercial or financial security), but generally the only options offered to a user are to report anybody's unblurred face or a visible license plate. In theory no one can help the householder in question without physically writing to him (which is possible – I saw their house number on Street View), and if theft is a concern then I'd recommend that he contacts Google to remove his car, garage, intriguing tarpaulin and caravan from Street View.

The best advice I can give today is to take a practical route: Google Street View is geared towards individuals reporting their own privacy 'concerns' – so check your property online, as well as that of friends and family. What is your first impression? What would a potential housebreaker or car thief make of it? If you see anything remotely troubling then click that 'Report a problem' link.

Who are you looking at?

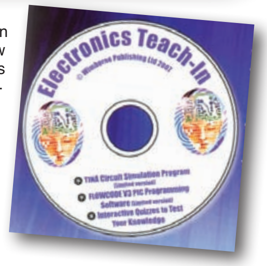
Just when I thought the dust had settled on Street View, on 1 April Google added another enhancement to StreetView: Pegman gained a pair of 3D glasses! By selecting the new 3D Pegman logo, Street View scenes were enhanced with a cyan and red outline, which gave a pseudo-3D rendering of the scenery. Sadly, shortly after my eBay 3D glasses (£1.59 delivered) arrived from Hong Kong, the 3D service was removed and there is now no trace of it. More background to Google's April Fool's Day spoof can be found on **http://tinyurl.com/yjmx8z3** and there are some samples of it dotted around the web.

As a sign of what lies ahead, Google recently purchased the British startup visual search firm Plink, whose Plink Art app for the Android mobile phone scans and hopefully recognises works of art, feeding back to the user the history and any other information available from its database. Plink is Google's first British technology acquisition, and an iPhone app is promised.

Google Labs hints at a future mobile GPS application called Google Goggles for the Android phone, which will utilise Plink expertise. Point your camera-phone at a book cover, a painting or a building and Google will try to recognise the image and feedback some results. It's early days yet, but Google Goggles will eventually be able to recognise where you are, as well as what you're looking at.

You can email me at **alan@epemag.demon.co.uk**.

Electronics Teach-In CD-ROM



Mike Tooley

A broad-based introduction to electronics – find out how circuits work and what goes on inside them. The CD-ROM contains the whole *Teach-In 2006* series (originally published in *EPE*) in PDF form, plus interactive quizzes to test your knowledge, TINA circuit simulation software (a limited version – plus a specially written TINA Tutorial), together with simulations of the circuits in the *Teach-In* series, plus Flowcode (a limited version) a high level programming system for PIC microcontrollers based on flowcharts.

The *Teach-In* series covers everything from Electric Current through to Microprocessors and Microcontrollers and each part includes demonstration circuits to build on breadboards or to simulate on your PC. There is also a MW/LW Radio project in the *Teach-In* series.

The interactive Review tests will help you to check your knowledge at the end of each part of *Electronics Teach-In*. You can take these tests as many times as you like, improving your score with each attempt.

The final test covers all aspects of *Electronics Teach-In* and will provide you with a means of checking your overall knowledge of electronics. Once again, you can take the test as many times as you like.

CD-ROM **Order code ETI – CD-ROM** **£8.50**

ROBOTICS

INTRODUCING ROBOTICS WITH LEGO MINDSTORMS
Robert Penfold

Shows the reader how to build a variety of increasingly sophisticated computer controlled robots using the brilliant Lego Mindstorms Robotic Invention System (RIS). Initially covers fundamental building techniques and mechanics needed to construct strong and efficient robots using the various "click-together" components supplied in the basic RIS kit. Then explains in simple terms how the "brain" of the robot may be programmed on screen using a PC and "zapped" to the robot over an infra-red link. Also, shows how a more sophisticated Windows programming language such as Visual BASIC may be used to control the robots.

Detailed building and programming instructions provided, including numerous step-by-step photographs.

288 pages - large format **Order code BP901** **£14.99**

MORE ADVANCED ROBOTICS WITH LEGO MINDSTORMS – Robert Penfold

Shows the reader how to extend the capabilities of the brilliant Lego Mindstorms Robotic Invention System (RIS) by using lego's own accessories and some simple home constructed units. You will be able to build robots that can provide you with 'waiter service' when you clap your hands, perform tricks, 'see' and avoid objects by using 'bats radar', or accurately follow a line marked on the floor. Learn to use additional types of sensors including rotation, light, temperature, sound and ultrasonic and also explore the possibilities provided by using an additional (third) motor. For the less experienced, RCX code programs accompany most of the featured robots. However, the more adventurous reader is also shown how to write programs using Microsoft's VisualBASIC running with the ActiveX control (Spirit.OCX) that is provided with the RIS kit.

Detailed building instructions are provided for the featured robots, including numerous step-by-step photographs. The designs include rover vehicles, a virtual pet, a robot arm, an 'intelligent' sweet dispenser and a colour conscious robot that will try to grab objects of a specific colour.

198 pages **Order code BP902** **£14.99**

ANDROIDS, ROBOTS AND ANIMATRONS
Second Edition – John Iovine

Build your own working robot or android using both off-the-shelf and workshop constructed materials and devices. Computer control gives these robots and androids two types of artificial intelligence (an expert system and a neural network). A lifelike android hand can be built and programmed to function doing repetitive tasks. A fully animated robot or android can also be built and programmed to perform a wide variety of functions.

The contents include an Overview of State-of-the-Art Robots; Robotic Locomotion; Motors and Power Controllers; All Types of Sensors; Tilt; Bump; Road and Wall Detection; Light; Speech and Sound Recognition; Robotic Intelligence (Expert Type) Using a Single-Board Computer Programmed in BASIC; Robotic Intelligence (Neutral Type) Using Simple Neural Networks (Insect Intelligence); Making a Lifelike Android Hand; A Computer-Controlled Robotic Insect Programmed in BASIC; Telepresence Robots With Actual Arcade and Virtual Reality Applications; A Computer-Controlled Robotic Arm; Animated Robots and Androids; Real-World Robotic Applications.

224 pages **Order code MGH1** **£16.99**

DIRECT BOOK SERVICE

The books listed have been selected by *Everyday Practical Electronics* editorial staff as being of special interest to everyone involved in electronics and computing. They are supplied by mail order direct to your door. Full ordering details are given on the last book page.

FOR A FURTHER SELECTION OF BOOKS SEE THE NEXT TWO ISSUES OF *EPE*

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All prices include UK postage

RADIO

BASIC RADIO PRINCIPLES AND TECHNOLOGY
Ian Poole

Radio technology is becoming increasingly important in today's high technology society. There are the traditional uses of radio which include broadcasting and point to point radio as well as the new technologies of satellites and cellular phones. All of these developments mean there is a growing need for radio engineers at all levels.

Assuming a basic knowledge of electronics, this book provides an easy to understand grounding in the topic.

Chapters in the book: Radio Today, Yesterday, and Tomorrow; Radio Waves and Propagation; Capacitors, Inductors, and Filters; Modulation; Receivers; Transmitters; Antenna Systems; Broadcasting; Satellites; Personal Communications; Appendix – Basic Calculations.

263 pages **Order code NE30** **£28.99**

PROJECTS FOR RADIO AMATEURS AND S.W.L.S.
R. A. Penfold

This book describes a number of electronic circuits, most of which are quite simple, which can be used to enhance the performance of most short wave radio systems.

The circuits covered include: An aerial tuning unit; A simple active aerial; An add-on b.f.o. for portable sets; A wavetrap to combat signals on spurious responses; An audio notch filter; A parametric equaliser; C.W. and S.S.B. audio filters; Simple noise limiters; A speech processor; A volume expander.

Other useful circuits include a crystal oscillator, and RTTY/C.W. tone decoder, and a RTTY serial to parallel converter. A full range of interesting and useful circuits for short wave enthusiasts.

92 pages **Order code BP304** **£4.45**

AN INTRODUCTION TO AMATEUR RADIO
I. D. Poole

Amateur radio is a unique and fascinating hobby which has attracted thousands of people since it began at the turn of the last century. This book gives the newcomer a comprehensive and easy to understand guide through the subject so that the reader can gain the most from the hobby. It then remains an essential reference volume to be used time and again. Topics covered include the basic aspects of the hobby, such as operating procedures, jargon and setting up a station. Technical topics covered include propagation, receivers, transmitters and aerials etc.

150 pages **Order code BP257** **£5.49**

COMPUTERS AND COMPUTING

ELECTRONICS TEACH-IN 2

USING PIC MICROCONTROLLERS A PRACTICAL INTRODUCTION

FREE CD-ROM

This *Teach-In* series of articles was originally published in *EPE* in 2008 and, following demand from readers, has now been collected together in the *Electronics Teach-In 2* book.

The series is aimed at those using PIC microcontrollers for the first time. Each part of the series includes breadboard layouts to aid understanding and a simple programmer project is provided.

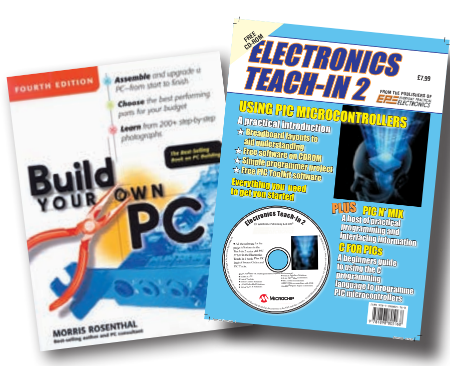
Also included are 29 *PIC N' Mix* articles, also republished from *EPE*. These provide a host of practical programming and interfacing information, mainly for those that have already got to grips with using PIC microcontrollers.

An extra four part beginners guide to using the C programing language for PIC microcontrollers is also included.

The free cover-mounted CD-ROM contains all of the software for the *Teach-In 2* series and *PIC N' Mix* articles in this book, plus a range of items from Microchip – the manufacturers of the PIC microcontrollers. The material has been compiled by Wimborne Publishing Ltd. with the assistance of Microchip Technology Inc.

The Microchip items are: MPLAB Integrated Development Environment V8.20; Microchip Advance Parts Selector V2.32; Treelink; Motor Control Solutions; 16-bit Embedded Solutions; 16-bit Tool Solutions; Human Interface Solutions; 8-bit PIC Microcontrollers; PIC24 Micrcontrollers; PIC32 Microcontroller Family with USB On-The-Go; dsPIC Digital Signal Controllers.

160 pages + CD-ROM **Order code ETI2** **£9.50**



BUILD YOUR OWN PC – Fourth Edition
Morris Rosenthal

More and more people are building their own PCs. They get more value for their money, they create exactly the machine they want, and the work is highly satisfying and actually fun. That is, if they have a unique beginner's guide like this one, which visually demonstrates how to construct a computer from start to finish.

Through 150 crisp photographs and clear but minimal text, readers will confidently absorb the concepts of computer building. The extra-big format makes it easy to see what's going on in the pictures. The author goes 'under the hood' and shows step-by-step how to create a Pentium 4 computer or an Athlon 64 or Athlon 64FX, covering: What first-time builders need to know; How to select and purchase parts; How to assemble the PC; How to install Windows XP. The few existing books on this subject, although outdated, are in steady demand. This one delivers the expertise and new technology that fledgling computer builders are looking for.

224 pages - large format **Order code MGH2** **£16.99**

PROGRAMMING 16-BIT PIC MICROCONTROLLERS IN C – LEARNING TO FLY THE PIC24 Lucio Di Jasio (Application Segments Manager, Microchip, USA)

A Microchip insider tells all. Focuses on examples and exercises that show how to solve common, real-world design problems quickly. Includes handy checklists to help readers perform the most common programming and debugging tasks. FREE CD-ROM includes source code in C, the Microchip C30 compliler, and MPLAB SIM software, so that readers gain practical, hands-on programming experience.

Until recently, PICs didn't have the speed and memory necessary for use in designs such as video- and audio-enabled devices. All that changed with the introduction of the 16-bit PIC family, the PIC24. This new guide teaches readers everything they need to know about the architecture of these chips, how to program them, how to test them and how to debug them. Lucio's common-sense, practical, hands-on approach starts out with basic functions and guides the reader step-by-step through even the most sophisticated programming scenarios.

Experienced PIC users and newcomers alike will benefit from the text's many thorough examples, which demonstrate how to nimbly side-step common obstacles and take full advantage of all the 16-bit features.

496 pages +CD-ROM **Order code NE45** **£38.00**

NEW FULL COLOUR COMPUTING BOOKS

WINDOWS 7 – TWEAKS, TIPS AND TRICKS
Andrew Edney

This book will guide you through many of the exciting new features of Windows 7. Microsoft's latest and greatest operating system. It will provide you with useful hints, tips and warnings about possible difficulties and pitfalls. This book should enable you to get much more out of Windows 7 and, hopefully, discover a few things that you may not have realised were there.

Among the topics covered are: A brief overview of the various versions of Windows 7. How to install and use Upgrade Advisor, which checks to see if your computer meets the minimum requirements to run Windows 7 and that your software and drivers are supported by Windows 7. How to use Windows Easy Transfer to migrate your data and settings from your Vista or XP machine to your new Windows 7 computer. Exploring Windows 7 so that you will become familiar with many of its new features and then see how they contrast with those of earlier versions of Windows. How to connect to a network and create and use Home Groups to easily share your pictures, videos, documents, etc.,with the minimum of hassle. Why Windows Live Essentials is so useful and how to download and install it. A brief introduction to Windows Media Center. The use of Action Center, which reports security and maintenance incidents. Windows Memory Diagnostic to detect the fairly common problem of faulty memory and Troubleshooting tools.

120 pages **Order code BP708** **£8.49**

HOW TO BUILD A COMPUTER MADE EASY
R.A. Penfold

Building your own computer is a much easier than most people realise and can probably be undertaken by anyone who is reasonably practical. However, some knowledge and experience of using a PC would be beneficial. This book will guide you through the entire process. It is written in a simple and straightforward way with the explanations clearly illustrated with numerous colour photographs.

The book is divided into three sections: *Overview and preparation* – Covers understanding the fundamentals and choosing the most suitable component parts for your computer, together with a review of the basic assembly. *Assembly* – Explains in detail how to fit the component parts into their correct positions in the computer's casing, then how to connect these parts together by plugging the cables into the appropriate sockets. No soldering should be required and the only tools that you are likely to need are screwdrivers, small spanners and a pair of pliers.

BIOS and operating system – This final section details the setting up of the BIOS and the installation of the Windows operating system, which should then enable all the parts of your computer to work together correctly. You will then be ready to install your files and any application software you may require.

The great advantage of building your own computer is that you can 'tailor' it exactly to your own requirements. Also, you will learn a tremendous amount about the structure and internal workings of a PC, which will prove to be invaluable should problems ever arise.

120 pages **Order code BP707** **£8.49**

AN INTRDUCTION TO eBAY FOR THE OLDER GENERATION
Cherry Nixon

eBay is an online auction site that enables you to buy and sell practically anything from the comfort of your own home. eBay offers easy access to the global market at an amazingly low cost and will enable you to turn your clutter into cash.

This book is an introduction to eBay.co.uk and has been specifically written for the over 50s who have little knowledge of computing. The book will, of course, also apply equally to all other age groups. The book contains ideas for getting organised for long term safe and successful trading. You will learn how to search out and buy every conceivable type of thing.The book also shows you how to create auctions and add perfect pictures. There is advice on how to avoid the pitfalls that can befall the inexperienced.

Cherry Nixon is probably the most experienced teacher of eBay trading in the UK and from her vast experience has developed a particular understanding of the issues and difficulties normally encountered by individuals.

So, if you are new to computers and the internet and think of a mouse as a rodent, then this is the book for you!

120 pages **Order code BP709** **£8.49**

GETTING STARTED IN COMPUTING FOR THE OLDER GENERATION
Jim Gatenby

You can learn to use a computer at any age and this book will help you acheive this. It has been especially written for the over 50s, using plain English and avoiding technical jargon wherever possible. It is lavishly illustrated in full colour.

Among the many practical and useful subjects that are covered in this book are: Choosing the best computing system for your needs. Understanding the main hardware components of your computer. Getting your computer up and runnning in your home. Setting up peripheral devices like printers and routers. Connecting to the internet using wireless broadband in a home with one or more computers. Getting familiar with Windows Vista and XP the software used for operating and maintaining your computer. Learning about Windows built-in programs such as Windows Media Player, Paint and Photo Gallery.

Plus, using the Ease of Access Center to help if you have impaired eyesight, hearing or dexterity problems. Installing and using essential software such as Microsoft Office suite. Searching for the latest information on virtually any subject. Keeping in touch with friends and family using e-mail. Keeping your computer running efficiently and your valuable data files protected against malicious attack.

This book will help you to gain the basic knowledge needed to get the most out of your computer and, if you so wish, give you the confidence to even join a local computer class.

120 pages **Order code BP704** **£8.49**

THEORY AND REFERENCE

ELECTRONIC CIRCUITS – FUNDAMENTALS & APPLICATIONS
Third Edition
Mike Tooley

A comprehensive reference text and practical electronics handbook in one volume – at an affordable price!

New chapter on PIC microcontrollers – the most popular chip family for use in project work by hobbyists and in colleges and universities.

New companion website: spreadsheet design tools to simplify circuit calculations; circuit models and templates to enable virtual simulation; a bank of on-line questions for lecturers to set as assignments, and on-line self-test multiple choice questions for each chapter with automatic marking, to enable students to continually monitor their progress and understanding.

The book's content is matched to the latest pre-degree level courses, making this an invaluable reference for all study levels, and its broad coverage is combined with practical case studies, based in real-world engineering contexts throughout the text.

The unique combination of a comprehensive reference text, incorporating a primary focus on practical applications, ensures this text will prove a vital guide for students and also for industry-based engineers, who are either new to the field of electronics, or who wish to refresh their knowledge.

400 pages **Order code NE43** **£25.99**

BEBOP TO THE BOOLEAN BOOGIE
Third Edition
Clive (Max) Maxfield

BOOK + CD-ROM

This book gives the 'big picture' of digital electronics. This indepth, highly readable, guide shows you how electronic devices work and how they're made. You'll discover how transistors operate, how printed circuit boards are fabricated, and what the innards of memory ICs look like. You'll also gain a working knowledge of Boolean Algebra and Karnaugh Maps, and understand what Reed-Muller logic is and how it's used. And there's much, MUCH more. The author's tongue-in-cheek humour makes it a delight to read, but this is a REAL technical book, extremely detailed and accurate. Comes with a free CD-ROM which contains an eBook version with full text search plus bonus chapter – An Illustrated History of Electronics and Computing.

Contents: Fundamental concepts; Analog versus digital; Conductors and insulators; Voltage, current, resistance, capacitance and inductance; Semiconductors; Primitive logic functions; Binary arithmetic; Boolean algebra; Karnaugh maps; State diagrams, tables and machines; Analog-to-digital and digital-to-analog; Integrated circuits (ICs); Memory ICs; Programmable ICs; Application-specific integrated circuits (ASICs); Circuit boards (PWBs and DWBs); Hybrids; Multichip modules (MCMs); Alternative and future technologies.

500 pages **Order code BEB1** **£32.99**

BEBOP BYTES BACK (and the Beboputer Computer Simulator) CD-ROM
Clive (Max) Maxfield and Alvin Brown

CD-ROM

This follow-on to Bebop to the Boolean Boogie is a multimedia extravaganza of information about how computers work. It picks up where "Bebop I" left off, guiding you through the fascinating world of computer design . . . and you'll have a few chuckles, if not belly laughs, along the way. In addition to over 200 megabytes of mega-cool multimedia, the CD-ROM contains a virtual microcomputer, simulating the motherboard and standard computer peripherals in an extremely realistic manner. In addition to a wealth of technical information, myriad nuggets of trivia, and hundreds of carefully drawn illustrations, the CD-ROM contains a set of lab experiments for the virtual microcomputer that let you recreate the experiences of early computer pioneers. if you're the slightest bit interested in the inner workings of computers, then don't dare to miss this!

Over 800 pages in Adobe Acrobat format

CD-ROM **Order code BEB2 CD-ROM** **£21.95**

FUNDAMENTAL ELECTRICAL AND ELECTRONIC PRINCIPLES
Third Edition
C. R. Robertson

Covers the essential principles that form the foundations for electrical and electronic engineering courses. The coverage of this new edition has been carefully brought in line with the core unit 'Electrical and Electronic Principles' of the 2007 BTEC National Engineering specification. This qualification from Edexcel attracts more than 10,000 students per year.

The book explains all theory in detail and backs it up with numerous worked examples. Students can test their understanding with end of chapter assignment questions for which answers are provided. In this new edition, the layout has been improved and colour has been added. A free companion website with additional worked examples and chapters is also available.

368 pages **Order code NE47** **£21.99**

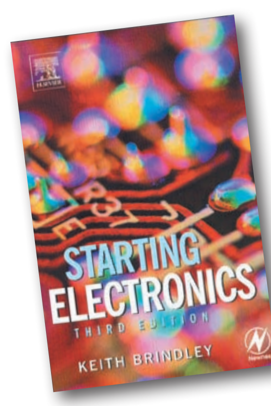
STARTING ELECTRONICS
Third Edition
Keith brindley

A punchy practical introduction to self-build electronics. The ideal starting point for home experimenters, technicians and students who want to develop the real hands-on skills of electronics construction.

A highly practical introduction for hobbyists, students, and technicians. Keith Brindley introduces readers to the functions of the main component types, their uses, and the basic principles of building and designing electronic circuits.

Breadboard layouts make this very much a ready-to-run book for the experimenter, and the use of multimeter, but not oscilloscopes, and readily available, inexpensive components makes the practical work achievable in a home or school setting as well as a fully equiped lab.

288 pages **Order code NE42** **£13.99**



MUSIC, AUDIO AND VIDEO

MAKING MUSIC WITH YOUR COMPUTER
Stephen Bennett

Nearly everyone with musical aspirations also has a computer. This same computer can double as a high quality recording studio capable of producing professional recordings. This book tells you what software and hardware you will need to get the best results.

You'll learn about recording techniques, software and effects, mixing, mastering and CD production.

Suitable for PC and Mac users, the book is full of tips, "how to do" topics and illustrations. It's the perfect answer to the question "How do I use my computer to produce my own CD?"

92 pages **Order code PC120** **£10.95**

QUICK GUIDE TO MP3 AND DIGITAL MUSIC
Ian Waugh

MP3 files, the latest digital music format, have taken the music industry by storm. What are they? Where do you get them? How do you use them? Why have they thrown record companies into a panic? Will they make music easier to buy? And cheaper? Is this the future of music?

All these questions and more are answered in this concise and practical book which explains everything you need to know about MP3s in a simple and easy-to-understand manner. It explains:

How to play MP3s on your computer; How to use MP3s with handheld MP3 players; Where to find MP3s on the Web; How MP3s work; How to tune into Internet radio stations; How to create your own MP3s; How to record your own CDs from MP3 files; Other digital audio music formats.

Whether you want to stay bang up to date with the latest music or create your own MP3s and join the on-line digital music revolution, this book will show you how.

60 pages **Order code PC119** **£7.45**

VIDEO PROJECTS FOR THE ELECTRONICS CONSTRUCTOR
R. A. Penfold

Written by highly respected author R. A. Penfold, this book contains a collection of electronic projects specially designed for video enthusiasts. All the projects can be simply constructed, and most are suitable for the newcomer to project construction, as they are assembled on stripboard.

There are faders, wipers and effects units which will add sparkle and originality to your video recordings, an audio mixer and noise reducer to enhance your soundtracks and a basic computer control interface. Also, there's a useful selection on basic video production techniques to get you started.

Complete with explanations of how the circuit works, shopping lists of components, advice on construction, and guidance on setting up and using the projects, this invaluable book will save you a small fortune.

Circuits include: video enhancer, improved video enhancer, video fader, horizontal wiper, improved video wiper, negative video unit, fade to grey unit, black and white keyer, vertical wiper, audio mixer, stereo headphone amplifier, dynamic noise reducer, automatic fader, pushbutton fader, computer control interface, 12 volt mains power supply.

124 pages **Order code PC115** ~~£10.95~~ **£5.45**

RADIO BYGONES

We also carry a selection of books aimed at readers of *EPE*'s sister magazine on vintage radio *Radio Bygones*. These books include, the four volumes of our own *Wireless For the Warrior* by Louis Meulstee. These are a technical history of radio communication equipment in the British Army and clandestine equipment from pre-war through to the 1960s.

For details see the UK shop on our web site at www.epemag.com or contact us for a list of *Radio Bygones* books.

PROJECT BUILDING AND TESTING

ELECTRONIC PROJECT BUILDING FOR BEGINNERS
R. A. Penfold

This book is for complete beginners to electronic project building. It provides a complete introduction to the practical side of this fascinating hobby, including the following topics:

Component identification, and buying the right parts; resistor colour codes, capacitor value markings, etc; advice on buying the right tools for the job; soldering; making easy work of the hard wiring; construction methods, including stripboard, custom printed circuit boards, plain matrix boards, surface mount boards and wire-wrapping; finishing off, and adding panel labels; getting "problem" projects to work, including simple methods of fault-finding.

In fact everything you need to know in order to get started in this absorbing and creative hobby.

135 pages **Order code BP392** **£5.99**

ELECTRONIC PROJECTS FOR EXPERIMENTERS
R. A. Penfold

Many electronic hobbyists who have been pursuing their hobby for a number of years seem to suffer from the dreaded "seen it all before" syndrome. This book is fairly and squarely aimed at sufferers of this complaint, plus any other electronics enthusiasts who yearn to try something a bit different. No doubt many of the projects featured here have practical applications, but they are all worth a try for their interest value alone.

The subjects covered include:- Magnetic field detector, Basic Hall effect compass, Hall effect audio isolator, Voice scrambler/descrambler, Bat detector, Bat style echo location, Noise cancelling, LED stroboscope, Infra-red "torch", Electronic breeze detector, Class D power amplifier, Strain gauge amplifier, Super hearing aid.

Temporarily out of print

PRACTICAL FIBRE-OPTIC PROJECTS
R. A. Penfold

While fibre-optic cables may have potential advantages over ordinary electric cables, for the electronics enthusiast it is probably their novelty value that makes them worthy of exploration. Fibre-optic cables provide an innovative interesting alternative to electric cables, but in most cases they also represent a practical approach to the problem. This book provides a number of tried and tested circuits for projects that utilize fibre-optic cables.

The projects include:- Simple audio links, F.M. audio link, P.W.M. audio links, Simple d.c. links, P.W.M. d.c. link, P.W.M. motor speed control, RS232C data links, MIDI link, Loop alarms, R.P.M. meter.

All the components used in these designs are readily available, none of them require the constructor to take out a second mortgage.

132 pages **Order code BP374** **£5.45**

GETTING THE MOST FROM YOUR MULTIMETER
R. A. Penfold

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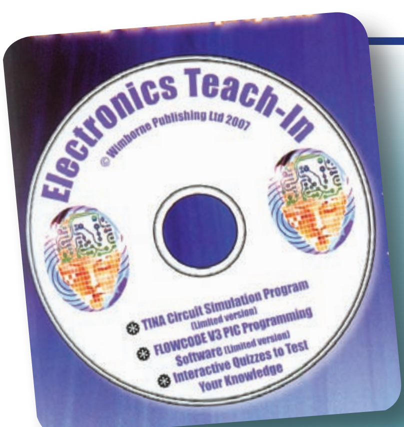

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NEXT MONTH

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Swimming pools are dangerous places, especially for toddlers. Reduce the possibility of a terrible accident in your swimming pool with this project. If someone falls in, an excruciatingly loud siren sounds a warning you can't ignore.

HOW TO SOLDER SMDs

We've all been there – you find the perfect circuit or project, just what you need, but then… 'oh no'… you need to solder SMDs. All too often we give up at this point – but now help is at hand. Jim Rowe shows how to painlessly solder these tiny components.

COLD ALERT

The ColdAlert is a PIC-based hypothermia alarm to help an elderly or vulnerable person stay warm over the winter months. It's a smoke-alarm-style low temperature detector with a fixed alarm threshold. It will give an audible and visual indication of low temperature, and features a built-in test facility.

DSP MUSICOLOUR PART 3: CALIBRATING AND OPERATING

In the last section of this project, we guide you through the final testing of the DSP Musicolour and give some troubleshooting tips. We also explain the operation of the firmware in more detail, as well as discussing possible accessories.

RECYCLE IT!

Next month, fax machines and hair trimmers are getting the 'recycle' treatment.

JULY '10 ISSUE – ON SALE 10 JUNE

Content may be subject to change

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